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XIX.—*Notes from the Gatty Marine Laboratory, St. Andrews.*—No. XL. By Prof. M'Intosh, M.D., LL.D., F.R.S., &c., Gatty Marine Laboratory, University, St. Andrews.

[Plates VII.-XII.]

On the Nervous System and other Points in the Structure of Owenia *and* Myriochele.

Since the remarks on *Owenia* and *Myriochele* were made in the volume on the British Marine Annelids lately issued by the Ray Society, a few observations on both types were carried out, though, unfortunately, no living forms could be obtained; yet *Owenia* formerly was cast on the beach at St. Andrews in hundreds, whilst *Myriochele* is not uncommon on the west coast of Ireland, and in certain foreign localities it occurs in swarms. Such blanks, which may stretch over many years in the British area, are in the case of the fishes often regarded as evidence of serious diminution: but, so far as observed during a long period of years, neither in the case of the fishes nor in the case of the invertebrates is there much of a basis for this supposition. The two forms above mentioned are of interest especially as regards their nervous system, which differs from that in the majority of the Polychæts in having the cephalic system as well as the

nerve-trunks wholly hypodermal. The latter arrangement of the ventral cords is that characteristic of most Polychæts —yet about ten families have their great ventral nerve-trunks enclosed by the muscular tissues of the body-wall, besides the basement-layer, hypoderm, and cuticle, showing how uncertain any single factor is in the classification of this group. In the Archiannelid *Protodrilus* the nervous system agrees with that in *Owenia* and *Myriochele* in being mainly hypodermic, and in *Saccocirrus* and *Sternaspis* (though this is not a Polychæt) the cerebral ganglion is similarly situated and the ventral nerve-cord is not segmented into ganglia. They contrast thus with the Nemerteans, in which the cephalic ganglia are internal and the longitudinal cords either enveloped in the muscular walls of the body or entirely within them. It is further interesting, in comparing the Nemerteans with the Polychæts, that no Polychæt possesses the proportionally large nerve-supply to any organ —a supply, moreover, more bulky in its distribution than in its origin, and which undergoes remarkable changes of form, both in contraction and dilatation—as that of the Nemertean proboscis. Hence its lattice-like arrangement gave rise to the term "elastic layer" in the early memoirs. This feature is as noteworthy as the passage of the proboscis between the dorsal and ventral commissures of the cephalic ganglia. Some consider that this arrangement of the nerves causes it to be an organ of sensation; but it is often thrown off when brought into contact with foreign bodies, and, though renewed, its functions for the interval are in abeyance. In the Ammocharidæ under consideration what appears closely allied to nervous matter is distributed as a continuous layer beneath the hypoderm of the gullet—a condition much more primitive than the elaborate system of the Nemertean proboscis or than the proboscis of a typical Polychæt such as *Nereis*.

In glancing at the literature of the subject, it is found that the acute and accomplished Claparède, familiar as he was with the ordinary nervous system of the Polychæta, failed to find the central nervous system in *Owenia* "qu'il m'a été parfaitement impossible d'en trouver la moindre trace chez l'*Owenia fusiformis* sur les coupes d'individus conservés"*, and he even had difficulty in discriminating the ventral cord in the fresh animal. Yet he had described and figured a similar condition to that of *Owenia* in *Telepsavus costarum*, one of the Chætopteridæ, in which the central nervous

* Annél. Sédent. p. 129.

system forms a subhypodermic band resting on the basement-tissue, and which Claparède interpreted as a transverse commissure between the ganglia*, yet to be considered as the representative of the cerebral ganglia, and the two eyes in *Telepsarus* rest on it. The ventral cords, moreover, show no ganglia and are wide apart. He does not allude to the minute structure of the nerve-tissue.

In 1885 von Drasche † gave a careful account, with figures, of the structure of *Owenia "filiformis"* as it occurred at Trieste, dealing in the first instance with the external characters, and especially the "Lippenorgan" at the oral aperture, the hypoderm and nervous system, the musculature, alimentary canal, cœlomic cavity, and long mucous glands. So far as he goes, the structure of these organs is correctly described, with accompanying figures. He could not satisfy himself as to the "nephridia" and the mode of exit of the genital products. He observed no nerve-cells in the minute structure of the central nervous system or in the ventral cord, only a fibrillar structure and Leydig's punctate substance. The ventral cord showed no ganglionic enlargements. Below the epithelium of the alimentary canal a strand similar in structure to the central system is briefly mentioned, but nothing definite is recorded concerning the nerve-supply of the internal organs nor concerning the nephridia.

In looking around for analogous relations of the central ganglia, it is found that in *Phoronis* Caldwell ‡ observed that the central nervous system remained in the epidermis, and therefore represented the primitive condition. In the adult the central system is in the form of a post-oral ring, the anus lying outside it. In *Phoronis buskii* of the 'Challenger' § the nerve-centre rests on a broad plate of basement-tissue, with the hypoderm externally extending from the nephridia forward to the centre of the whorl of tentacles on each side, and it agrees precisely in minute structure with that in *Cephalodiscus* and *Owenia*.

The central nervous system in *Cephalodiscus dodecalophus* ‖ occupies an area of considerable proportional size at

* Annél. Sédent. p. 127.

† 'Beiträge zur feineren Anatomie der Polychaeten,' Zweites Heft, Wien, pp. 1–22, 2 plates.

‡ Proc. Roy. Soc. vol. xxxiv. p. 372.

§ Zoology, vol. xxvii. part 75, pp. 18–21, pl. ii. figs. 1 & 2, pl. iii. figs. 1–3;

‖ 'Challenger,' Zoology, vol. xx. part 62, p. 23, pl. vi. fig. 3, and pl. vii. fig. 3

the base of the plumes external to the median space, and is bounded externally by the thick coat of hypoderm and internally by the basement-layer. It extends laterally in the hypoderm along the basal region of the plumes and for some distance along the dorsal side of the buccal shield. In microscopic structure it is minutely cellular and granular, intermingled with fibres, and corresponds generally in position with that in *Owenia* and *Myriochele*.

Benham * (1896) described the central nervous system of the "Archiannelida" as in contact with the epidermis, and pointed out that in some Polychæta it holds a similar position in the epidermis; but he does not mention this condition in the Ammocharidæ, which he associates with his Spioniformia, nor in the Chætopteridæ included by Levinsen and himself under the same group or suborder.

Gilson (1897–98) devoted much attention to the structure and function of the various parts of *Owenia*. Besides a careful account of the remarkable secreting glands †, which form such prominent organs, he has furnished an extended description of the "valves septales" ‡ and of "cellules musculo-glandulaires" in the body-wall §. Perhaps the most important contribution is that connected with the "valves septales," wherein he gives a systematic description of each septum, with its functions, one of the most striking being the second septum (*i. e.*, between the fourth and fifth segments), his sphincter muscle being in the position of the ordinary oblique muscle at its insertion over the nerve-cord. The muscular arrangements of this septum are specially connected with the cœlomic fluid and the branchiæ. After describing the special apertures in the septa and their mechanism, he shows that apertures at several of these connect the cœlom with the exterior; that in the sixth segment two zigzag cutaneous canals springing from funnels at the septum between the sixth and seventh segments perform the function of genital ducts, since nephridia are absent—a feature of a peculiar character in a Polychæt. In his paper on the musculo-glandular cells he states that a peritoneal membrane or cœlomic coat proper is absent in *Owenia*, thus resembling such forms as the Nematodes, Acanthocephali, many Annelids and Archiannelids. The body-wall is formed by a combined musculo-glandular coat—that is, it cannot be separated into a muscular and a glandular layer. The inner

* Camb. Nat. Hist., Worms, Rotifers, and Polyzoa, pp. 243, 255, & 325.
† 'La Cellule,' t. x. fasc. 2.
‡ *Ibid.* t. xii. fasc. 2. § *Ibid.* t. xiv. fasc. 2.

region of this coat secretes albuminoid substances, fat, and urinary products. As will be shown subsequently, such is a misapprehension of the structure of the peritoneal surface, probably owing to the condition of the accomplished Belgian author's material.

In connection with Gilson's opinion, for it is nothing more, that the hypodermic canals in the sixth segment are genital ducts, it is noteworthy that Arnold Watson observed the reproductive elements in *Owenia* issuing from two pores, to the right and left of the anus, a portion of the posterior end of the body projecting from the anterior aperture of the tube. Thus Gilson's theory of the advantages of the anterior opening of the hypodermic tubes (his genital ducts) lapses, were it only by the thrusting out of the much more delicate tail anteriorly.

Ogneff* (1899), working at the Naples Station, took up the subject of Gilson's "cellules musculo-glandulaires" in *Owenia*. In his preparations he found within the muscular layer of the body-wall a protoplasmic and cellular layer which lined the cœlom. In the muscle-fibres of the longitudinal coat themselves were spindle-shaped cells with nuclei, as Schwalbe first described in the muscles of worms and lamellibranchiate mollusks, and also on the surface of the muscles in a protoplasmic layer. Over these, however, is a layer of peritoneal cells, which are cup-shaped, with rounded inner or deeper surfaces and flattened surfaces toward the cœlom, with an oval nucleus, fat, and granules like the white of egg in the protoplasm. A fine protoplasmic network stretches from these amongst the muscle-cells. He thought there were as many as fifteen to twenty peritoneal cells to one muscle-cell. He did not consider that Gilson's "muscle-gland-cells" existed in *Owenia*, the misapprehension being due to the less elaborate methods of preparation and section-making.

In 1900 a very interesting paper on *Owenia fusiformis* was communicated to the Linnean Society by Mr. Arnold Watson†, whose observations on the living animals are noteworthy. His description of the lip-organ and its functions, the occurrence of a prostomial pore, the discovery of the emission of the sexual elements through two cœlomo-ducts (anal pores), the structure and repair of the tubes, and the rearing of the ova to the *Mitraria*-stage are the chief features of this contribution to the life-history of the species.

* Biol. Centralblatt. Bd. xix. p. 136.

† Journ. Linn. Soc. vol. xxviii. p. 259, pl. xxii.

One of the latest contributions is a histological paper on *Owenia* by Zürcher*, who enters into the minute structure of the muscles, showing that the long spindle-shaped muscle-cells have a spiral character (formerly noted by Ogneff), which in transverse section give them a barred aspect. A circular muscular coat occurs only at the second dissepiment and forward to the branchial lobes. This also has spindle-shaped cells with nuclei. He combats Gilson's view, as Ogneff had previously done, that there is no line of demarcation between the muscular coat and the peritoneum, that the nuclei are rare in the muscular fibres and by-and-by vanish, and that it is impossible to distinguish the nuclei of the muscles and those of the gland-cells. He points out that the peritoneal nuclei are generally rounded, whereas the nuclei of the muscles are oval and flattened, with the long axis in the line of the muscle-cell. He goes somewhat fully into the histology of the circulatory system (his hæmocœl), the main trunk consisting of a dorsal vessel carrying the blood forward and a ventral trunk carrying it backward. The dorsal forms a blood-sinus round the gut to the second septum, then breaks up into a network over the canal, the trunks fusing at the first septum and sending forward a series of vessels to the branchiæ, the returning vessels uniting to form the ventral trunk below the gut. The walls of the vessels have a fine epithelial coat and a delicate circular muscular layer with minute nuclei in their spindle-shaped cells. The author also objects to Gilson's statement that no special constrictor to the alimentary canal occurs at the septa, and points out that at the third septum an efficient constrictor apparatus exists both for the canal and the blood-sinus, the muscular apparatus showing the large muscle-cells at the outer ends of the fibres. Posteriorly also the alimentary canal is moniliform from its constrictions. He is inclined to think that Drasche's bladder-like tissue on the ventral mesentery is part of the reproductive apparatus. The ampullæ on the ventral blood-vessel, which Drasche observed to be rythmically contractile, are confined to the genital region of the body, and bear the reproductive elements on their outer surfaces, and, though they have muscular walls, Zürcher would attach more importance to their nutritive capacity. The red blood contains rounded or lenticular corpuscles with nuclei, and some corpuscles undergo mitosis. He found them in the ampullæ and less

* Jenaische Zeitschr. für Naturwiss., Bd. xlv. pp. 181–220, pls. vi.–x. (1909).

frequently in the vessels and sinuses. There is a mixture of venous and arterial blood in the branchiæ. The author does not touch on the structure of the nervous system of *Owenia*, the topography of the alimentary canal, the hypodermic canals of the sixth segment, and other features subsequently to be described, and his main points are histological. The illustrations are chiefly in outline.

No trace of a central nervous system is observed in *Owenia fusiformis* till the folds of the mouth are cut in the transverse sections*, and the first definite appearance of a layer similar to nerve-tissue is the presence of a pale band external to the stained basement-layer of the inner border of a lateral flap of the mouth. It resembles a differentiated stripe of hypoderm from which cells and pigment are absent, but the fine striæ are continued through it to the basement-tissue, the whole being minutely fibrillar like the nerve-tissue, and generally dotted with minute granules. It fades away before reaching the free or ventral edge of the lateral flap, and disappears similarly at the dorsal edge of the fold. Then (for it is difficult to cut exactly on the same level) a corresponding band appears on the opposite labial fold. This pale belt is considered by some, *e. g.*, Zürcher, to be basement-tissue, but it seems to be somewhat different. In any case, the contrast between it and the condition, for instance, in the proboscis of the armed Nemertean with its large strands of nerves and their reticulations is marked, yet

* Whilst many advantages are gained by the use of paraffin, celloidine, and other substances for imbedding, the old plan of fine sections made directly from carefully prepared spirit-specimens is not without value in checking the proportional thickness of the muscular layers and other parts. Thus, in the case of *Owenia* the great thickness of the longitudinal muscles of the body-wall can only be appreciated in this way, and so with the proportional size of the mucous glands and the tough nature of the basement-layer. In such preparations more than forty years old the delicacy of the hypodermic[1] layer has caused most of it to be removed in the manipulations before and after preservation, but in every case the nerve-cord firmly adheres to the basement-tissue in the mid-ventral line, thus demonstrating its comparatively tough nature in contrast with the hypoderm. In such sections the gut fills the entire area, with the exception of the mucous glands, though, of course, in life the cœlomic space was larger. The term hypoderm in the structure of the Polychæta refers to the glandular and granular layer, often areolated, beneath the cuticle. It is an ectodermic structure.

[1] I am indebted to Mr. E. W. Shann, B.Sc., now Captain in the Northumberland Fusiliers, Mr. J. W. Pryde, M.A., now Lieutenant in the Black Watch, and to Miss Harvey, of Edinburgh, for aid in making the various sections.

the functions of both are equally well performed. The Nemertean brain, as in many Polychæts, is distinctly isolated from the tissues outside it, and the same may be said of the main trunks in that group. Here, in what is considered to be a higher series, the opposite condition prevails, the nerve-centre and main trunks being hypodermal, as are the cords in the majority of the Polychæts. In *Owenia* this belt agrees in minute structure with that surrounding the central system, and occupies a corresponding position.

With the disappearance of a central fillet in the dorsal arch of the body-wall a slightly pale band is noticeable in the hypoderm of the region, yet that layer passes to the basement-tissue (which stains) uninterruptedly, a series of the ends of severed fibres being grasped in spaces bounded by reticulations between the basement-tissue and the adjoining circular muscular fibres. Then the pallor of the inner portion of the hypoderm becomes more pronounced, and in the next section or two (Pl. VII. fig. 1) a distinct nervous layer, as in *Cephalodiscus*, stretches along the mid-dorsal arch. It shows both fine transverse and vertical fibres or striæ, and minute granules occur next the basement-tissue (Pl. VII. fig. 2). It fades on each side into the ordinary cells and areolæ of the hypoderm, which likewise continues to the surface externally without evident break. The nerve-tissue, in short, is marked by no hard-and-fast line from the hypoderm, but is traversed by its fibres, and the neuropile, nemoglia, and neurilemma of the ordinary Polychæt ganglia are not distinguishable. From end to end in section the tissue has a uniform structure, and where, for instance, it is separated from the basement-layer only projecting vertical fibres and granules appear. Certain granules occur at its outer border next the deeply stained cells and granules of the hypoderm, but these could not be associated with the nerve-band, the finely fibrillar edge of which coursed evenly along. In succeeding sections this great nerve-band stretches downward at the sides, becomes more distinctly differentiated from the hypoderm externally and the basement-tissue internally, and then a slight narrowing of the mid-dorsal arch takes place, the lateral extensions being thicker. The mouth is still divided ventrally in these sections, and the nervous expansion extends over the entire arch of the body-wall with the exception of a comparatively short region of the ventral edge of the lateral lip, the thickest layer being lateral, for the dorsal is now diminishing. A narrow layer, apparently of basement-tissue, occurs, as indicated, simultaneously in the sections external to the hypoderm lining the mouth, and

at this level all round, though it is thickest ventro-laterally, and it was this layer which was first encountered in front. The structure of this lateral band of so-called basement-tissue closely resembles that of the central system, and it is possible that it may perform functions of a sensory kind in connection with the lateral flaps of the vestibule. The flaps gradually unite to form the lower half of the vestibule, the thicker band of pale tissue still being retained ventrally with a thin connecting-band dorsally. Proceeding a little backward the main nervous band disappears from the dorsum and is confined to the lateral regions of the body-wall, from which it gradually thins off dorsally. Finally, when the lip-organ appears in the section over the oral gap, a large nerve-cord alone is left at the lower limit of the former nerve-band (Pl. VII. fig. 3, *nc.*), all the hypodermic layer dorsad of it having assumed the usual condition. In sections of *Succocirrus* near the mouth Dr. Goodrich * found the lateral cords (his "œsophageal commissures") in a similar position. This limited nerve-area presents in section pale, finely granular, transverse striation, through which delicate fibrils from the hypoderm external to it pass to the basement-tissue. When the circle of the body-wall is complete—that is, immediately behind the oral gap (Pl. VII. fig. 3).—the large nerve-cords are situated a little below the middle line of the body-wall, and have a blood-vessel in the muscle to their inner side. The central region is still lined by hypoderm, and the thick pale band of the inner layer is infero-laterally conspicuous. Then the hypodermic layer of the vestibule passes into the gullet, and sections of the lip-organ (*lp.*) appear, whilst the hypodermic inner lining of the dorsal region is shut off by a deep fold with a narrow layer of hypoderm from the vestibule, the rest of the large arch above having a thick coat of the same tissue. Externally, again, a change has occurred in the mid-ventral line, for the thick lateral coat of hypoderm in which the nerve-cords lie has thinned off ventrally, leaving a considerable area with just a trace of it; but this appears to occur only for a short distance. With the termination of the vestibule lined by hypoderm, and the increase of the lip-organ in section, the ventral hypoderm of the body-wall again gradually thickens from the middle line outward. Moreover, the narrow pocket formed by the first septum lies on each side of the lip-organ (Pl. VII. fig. 4), and then is quite shut off from the upper cavity (vestibule) lined by hypoderm, and which represents the

* Quart. Journ. Micr. Sci. n. s., vol. xliv.

gullet proper (which may have complex functions), surrounded by a tough (muscular) investment, from which various strands radiate to the body-wall amongst the blood-vessels of the region. The body-wall at this part has a thinner coat of hypoderm both mid-dorsally and mid-ventrally, its thick layer being lateral. The longitudinal muscles form a somewhat thin layer of fasciculi all round, and the lip-organ shows a thick mass of modified vertical cells with nuclei, each mass probably rubbing against the other. The massive lip-organ then forms a thick-walled tube in section, with a central cavity (Pl. VII. fig. 5) and an external muscular investment, whilst the œsophagus has a thick mucous layer, continuous with the hypoderm, to subserve its special functions, the radiating strands and numerous blood-vessels still continuing. These radiating fibres show that the movements of this thick-walled region (Pl. VIII. fig. 18) must be more or less restricted, yet the longitudinal bands, especially on its dorsal wall, would point to protrusion and retraction. Externally the hypoderm—thickest laterally at and above the nerve-cords, which are descending—has increased in depth dorsally, but is thin ventrally. Behind the foregoing the lip-organ loses its central cavity (a fold) and diminishes in size, but its complex muscular coat is proportionally thicker, and in the surrounding area the blood-vessels are larger. Finally, the muscles of the lip-organ alone are visible, and then disappear, showing that it is, in short, attached by a muscular stalk, first hollow and then solid, though the sections would indicate that the muscular fibres (retractor) are fixed to the body-wall close behind and for some distance backward. Moreover, a fan-shaped arrangement (Pl. XII. fig. 17) occurs anteriorly where the fibres spread into the lip-organ. Besides, various oblique and transverse fibres act on the folds and give complexity to the movements (Pl. XI. fig. 16). A double layer of muscular fibres, further, lies beneath the basement-tissue bounding the gland-cells—the one the reverse of the other,—so that in sagittal section the cut ends of one series abut on the thick inner (*i. e.* toward the cœlom) belt. Gland-cells also occupy considerable areas internally at the edge of the organ. The whole structure of this organ therefore differs from mere labial folds of the vestibule, as more clearly seen in vertical sections (Pl. VII. fig. 6), the densest part of the cellular layer being toward the middle of the ventral fold and thinning off dorsally and laterally. The lip-organ, in short, is a highly differentiated apparatus, both secretory and manipulative, for the tube-formation and other

functions. It is interesting that Dr. Goodrich * found a similar organ (his "muscular pad") in *Saccocirrus* and *Protodrilus*. The body-wall at this level again presents a change in its hypoderm (which throughout has a firm exterior film or cuticle), since, though somewhat diminished dorsally, it is now of a considerable thickness mid-ventrally, its densest part being at the nerve-cords, which have moved downward, so that they are separated by about a sixth of the circumference of the body (Pl. VIII. fig. 7). The œsophagus has special fasciculi of muscles laterally and dorsally, besides the radiating fibres.

The next important change is the merging of the œsophageal region of the canal, with its boldly arranged coat continuous with the external hypoderm, into the stomachal region at the third septum, with its granular glandular surface (Pl. VIII. fig. 7) and its external muscular coat, the whole internal surface of the stomach being by-and-by thus transformed.

At the commencement of this region of the gut at the third septum a complex muscular sheath connected with the lip-organ occurs ventrally, with thickened muscular pillars at each side—abutting on a membranous space to the exterior and just over the nerve-trunks, certain of the fibres, moreover, a little further back being attached to the basement-tissue over the outer part of the nerve-cords. Blood-vessels occur in the large space which is thus soon formed below the alimentary canal, and the vessel in the median mesentery (which is attached to the upper border of the mass of muscle stretching from side to side over the area above the nerve-cords—a little behind the section figured in Pl. VIII. fig. 7) is distinct, the special mesenteric area still being visible externally, though much reduced in size. Between the basement-tissue of the body-wall and this transverse muscular mass lie the ventral longitudinal muscles (*vm.*). The great cavity appears to contain cœlomic fluid and corpuscles, and is shut off by a shelf of septal tissue (Pl. VIII. fig. 7, *bt.*) continuous at each side with that of the body-wall, whilst the upper area on each side of the alimentary canal is occupied by elastic connective-tissue strands and by the muscular fasciculi along the dorsal wall of the canal. The body-wall at this region has dorsally the longitudinal muscles (*dm.*), which may be held to cease at the junction of the transverse platform of septal tissue a little below the middle, of longitudinal muscular fibres

* Quart. Journ. Micr. Sci. n. s., vol. xliv. p. 415, sections 18 & 20.

ending at the junction of the ventral transverse band, and, lastly, of the median (ventral) longitudinal fibres (*vm.*) beneath the latter (Pl. VIII. fig. 7). The nerve-cords at this part are separated by fully a sixth of the circumference of the body-wall. The transverse septal plate above the ventral longitudinal muscles has a central structureless part —apparently of a homogeneous nature (pale and elastic), the muscular fasciculi fraying out especially at the dorsal surface and ends (Pl. VIII. fig. 7 A). In its progress backward a change in the diminishing area between the nerve-trunks is inaugurated, the homogeneous central region of the transverse band, the anterior part of which is indicated in Pl. VIII. fig. 7, being shortened transversely and increased vertically, so that it pushes as a lozenge-shaped and then wedge-shaped area into the centre of the ventral muscular mass, whilst the upper muscular fibres externally become defined as more or less independent masses, bounded externally by sloping muscular fibres which simulate the oblique in certain sections—at least, at their insertion. The lozenge-shaped area of the homogeneous (for it can scarcely be called "tendinous") tissue thins off on each side to a plate, to the upper edge of which fasciculi of muscular fibres are attached, whilst ventrally processes pass into the median ventral longitudinal muscles. The whole thus forms a complex muscular apparatus attached to the central tough tissue, which gradually in its progress backward shrinks, leaving the fused muscular fasciculi to form the massive ventral longitudinal muscles as shown in Pl. VIII. fig. 8, *vm.* By the gradual diminution of the tough central area of the before-mentioned transverse band to which the median mesentery from the gut is attached, and by the grouping of the several longitudinal ventral muscles into a mass on each side, the typical ventral longitudinal muscles are formed, and at this part they exceed in bulk the dorsal muscles. This evolution of these continuous ventral fasciculi out of the elements in front is probably connected with a change in the function of the contents as well as in the body-wall itself.

The disappearance of the longitudinal muscular fibres and the radiating strands from the dorsal wall of the gut leaves the two halves of the upper division of the cœlomic space for cœlomic fluid only, and it is separated from the two much larger spaces inferiorly by strong muscular bands at each side of the transversely enlarged alimentary canal; yet the appearance of the canal beneath—to which the median mesentery is attached ventrally—apparently leaves a gap by

which the two cavities communicate superiorly under the transversely enlarged canal.

The anterior end of the stomach is a narrow tube as seen in Pl. XI. fig. 23, and in the various transverse sections. It further presents a bifid border ventrally, a narrow process of the cavity ending in a dilated rim on each side below, the ventral blood-vessel and the mesentery occupying the gap, whilst a spacious sinus surrounds the stomach. This bifid condition gradually disappears, the organ assuming the outline shown in Pl. X. fig. 30.

A mesentery with the dorsal blood-vessel in the centre passes from the upper arch of the gut to the dorsal wall, and another mesentery, with the ventral blood-vessel, goes to the mid-ventral tissues, the cœlom being thus divided into halves. Then a process from the wall of the stomach above the rugose and somewhat triangular ventral arch appears, and a little behind is tacked to the ventral portion, and thus cuts it off as a separate canal with folded mucous membrane internally, the longer upper chamber having its inner surface smooth and symmetrically folded. The inferior and somewhat pear-shaped chamber (Pl. VIII. fig. 8, *st.*, stomach) is surrounded by blood-vessels, which form a vascular plexus around it on their way to the branchial region, and from its apex inferiorly a mesentery passes to join a mid-ventral homogeneous (pale tough) area arching over a special muscular region which terminates on each side over the outer edge of the nerve-cord, now approaching that of the opposite side.

At this level the body-wall has thin hypoderm in the mid-dorsal line, then it increases in depth laterally, again becomes thinner, and then swells out ventrally at the nerve-cords. Within are the basement-tissue and circular fibres, then the dorsal longitudinal muscles (*dm.*), which end below the attachment of the upper canal on each side, and the ventral longitudinal (*vm.*), which are more massive, and have the differentiated region with the arched fibres in the middle line, such, indeed, forming the only separation between them. This differentiated region is probably in connection with the movements of the alimentary canal. The nerve-cords in section show a granular and fibrillar aspect, and they are much better differentiated than in front. The occurrence of bristle-tufts makes the separation between the dorsal and the ventral longitudinal muscles more pronounced, and below the tuft is a well-defined pore of the mucous gland with large nuclei in its cellular wall (Pl. VIII. fig. 9. *mp.*), one side abutting on the hypoderm, the other

having muscular fibres from the bristle-tuft attached to it; and the hypoderm is thinned at the tuft and has an incurvation at its upper edge, whilst it rapidly thickens above it. Moreover, a distinct muscular slip (*mc.*) occurs in the mid-ventral line, the remnant of the complex condition in front.

The next change is the infolding of the stomachal wall (Pl. VIII. fig. 10, *st.*), the loss of its lateral connections, and the termination of its cavity; whilst the intestine enlarges, its folds become more prominent and alter their character, resembling, indeed, the œsophageal hypodermic lining. The intestine still shows a plexus of vessels, about seven, for instance, being cut on each side, and they resemble buds from the investment of the gut, though they are only sections of longitudinal trunks with their internal and external investments. The dorsal mesentery and its enclosed vessel now pass upward from the gut-wall, and inferiorly are the ventral mesentery and its vessel, the membrane trending to a fissure between the more massive ventral longitudinal muscles, since the special median muscular area and its fibres (shown in Pl. VIII. fig. 7 A) have disappeared. The nerve-cords are separated only by their own breadth from each other, and they are, perhaps, more distinctly granular than before. The mucous glands, with their secretion rendered fibroid by preparation, are now prominent, each placed above the ventral muscle of its side. The cœlomic spaces (Pl. IX. fig. 11, *c.*), reduced to one on each side, have a translucent coagulum with granules.

When the nerve-cords touch and fuse (Pl. IX. fig. 11, *nc.*) it is seen that the glandular tubes in the cœlom approach each side of the ventral vessel, and slope outward as they go forward to the excretory duct below the bristle-tuft. The gut has become pear-shaped, the narrow end being below with its mesentery, whilst two mesenteries pass from the dorsal arch and join before reaching the dorsal blood-vessel. This arrangement makes an additional supra-intestinal chamber.

The hypoderm still presents a symmetrical enlargement just above the bristle-tuft on each side, this thickened region being differentiated by the narrow layer immediately above it, for it gradually deepens dorsally and again becomes narrow as it reaches the mid-dorsal line. From the lower edge of the bristle-tuft it gently increases to the nerve-cords in the mid-ventral line. The dorsal longitudinal muscles are thinner than the massive ventral, but they extend over a larger area of the body-wall.

A little further back (Pl. IX. fig. 12) the gut increases in

vertical diameter, forming a long flattened organ extending from the dorsal to the ventral region in section, and the cellular lining is thrown into rugæ. Both dorsal and ventral short mesenteries are double, and the wall of the dorsal vessel is more muscular. The gut has the same vascular investment as just mentioned, and the vessels lie outside the mesentery just alluded to. At the next bristle-bundle a pore similar to the first gives issue to the secretion of the second pair of glandular tubes. The ventral longitudinal muscles retain their more massive outline.

After an interval the body (Pl. IX. fig. 13) increases in bulk proportionally, but the hypoderm becomes thinner all round, the thickest part being that situated ventrally on each side of the nerve-cords. The ventral longitudinal muscles pass far upward, and encroach on the dorsal, which occupy only the upper arch of the body, and each pair has a distinct median notch into which the mesentery fits, the ventral mesentery having the ovaries or spermaries attached to it laterally, and the contents of which are shed into the cœlom. Two mucous glands in section occupy the upper half of the cœlom on each side, and the nuclei of the cells forming their walls are regularly arranged. The gut stretches nearly from dorsal to ventral arch, held in position by the median mesenteries and also by the septa at intervals. The double attachment superiorly forms a blood-channel, which communicates with a sinus (*sin.*) surrounding the gut, so that here, instead of the isolated though reticulated vessels, there is a continuous blood-channel—a development in all probability attained only in the adult or nearly adult condition. The nerve-cord still has numerous hypodermic fibres passing from the outer to the inner (ventral to dorsal) or *vice versa*, and, in addition, fine reticulations and granules, some of which are probably nuclei. Usually a slight ventral furrow and a median peak dorsally indicate the double nature of the area. The second pair of glandular tubes is situated to the exterior of the first pair in transverse sections.

The sixth segment is distinguished by the presence of Gilson's epidermal tubes, which stretch from the septum between the sixth and seventh segments to that in front. They are readily recognized by their position in transverse sections, viz., dorsad of the groove (Gilson's "gouttière de la soie") which runs along the dorso-lateral region. They are canals of considerable size, and are separated from the basement-layer by a stratum of cells, the cavity in section being also bounded externally by an arch of hypodermic cells. Gilson supposed that these hypodermic canals served

for the transmission of the reproductive elements, and possibly also for an interchange between the cœlomic cavity and the exterior as in certain Oligochæts. True nephridia, at any rate, are absent in *Owenia*. Whatever the function of these canals may be, Arnold Watson has shown that sperms and ova escape by different channels.

In front of the tail the hypodermic coating of the surface is of moderate thickness. The massive muscular investment is conspicuous, and it is difficult to distinguish where the dorsal longitudinal muscle ends and the ventral begins, though a fold above the mucous gland seems to indicate the separation. The nerve-cords have shrunk to a small lenticular area, which in minute structure has the same fibrillar and granular character as in front. The intestine, held in position by a dorsal and a ventral mesentery, is considerably less, but it has large vessels or sinuses on each side, the ampullæ from the ventral vessel passing into the large gonad below the gut. Two mucous glands are still in evidence under the dorsal wall, and they have the same character as in front. Moreover, their ducts open above the long line of hooks in the space between these and the bristle-tuft, which is now dorsal in position, and so leave the entire lateral wall to the hooks; thus the restricted area occupied by the dorsal longitudinal muscles is defined. The whole lateral and ventral regions are covered by the ventral longitudinal muscles, which, however, are much thinner than the dorsal, the reverse of the condition in front. The conspicuous development of the gonads in this region and the ampullæ of the ventral vessel are noteworthy. The mucous glands have now ceased (Pl. IX. fig. 14).

One of the interesting features toward the tail is the occurrence of the septa (Pl. IX. fig. 15). Their first appearance is indicated by the envelopment of the intestine and its blood-sinuses by a sheath which springs from each side of the vertical mesentery under the dorsal blood-vessel, and stretches to the mid-ventral mesentery considerably below the ventral blood-vessel. In such a view it might be supposed that the middle of the septum has been sliced, leaving the upper and lower attachments; but such will not explain all the outlines of these posterior septa.

Reproductive elements occur in the spaces outside the septum as well as within it and its areas. Then the upper and lower arches separate, each having a zigzag outline as it passes to the body-wall. The cœlom is thus divided into six areas—two dorsal, two ventral, and the lateral with the gonads inferiorly on each side of the gut.

The first appearance of the septum in the sections is heralded by a tuft of muscular fibres attached to the exterior of the gut-wall and the ventral septum; then the muscular ring (the ventral septum and the gut being free) loosely envelops the gut and its vessels, besides the ventral blood-vessel and its mesentery, almost to the ventral longitudinal muscles, but leaves the dorsal blood-vessel for the most part free. The septum, indeed, springs on each side from the lower wall of the vessel, and encloses that part of the mesentery between the vessel and the sinus around the gut, whilst the distal part of the mesentery passes freely to the gap between the dorsal longitudinal muscles. This muscular sheath or tubular chamber by-and-by swells out into a large area, its upper arch or roof being attached on each side to the body-wall between the dorsal and ventral longitudinal muscles, and its floor stretches from the median ventral mesentery to the wall of the body a considerable distance below the attachment of the roof. This chamber encloses the alimentary apparatus and the gonads, but the more advanced sperms lie in the two cœlomic chambers outside its roof—that is, between the latter and the body-wall (Pl. IX. fig. 15). It is difficult to explain the exact nature of these septa—whether they are modifications of the ordinary septa, which extend far backward in the caudal region, or only the ordinary septa sliced so as to present these characteristic appearances,—for it is unlikely that two septa would fall into the line of section. These septa seem to differ in disposition and aspect from those in front, and are probably associated with the special functions of the caudal region—respiratory, purely intestinal, or otherwise.

On viewing the animal externally from the dorsum, a broad fillet passes from each side of the collar anteriorly and slopes obliquely inward and backward on the dorsum to the constriction behind the third bristle-tuft, then bends a little outward, and is continued along the dorso-lateral region posteriorly. A groove exists at the collar just below the anterior end, and which apparently is functional also for the median ventral ridge and groove, so that, if ciliated, it may send a current outward and forward to it. These ridges apparently are those which show the remarkable pennate arrangements in the hypoderm in the preparations (Pl. IX. fig. 20).

In certain longitudinal sections (Pl. VIII. fig. 18) the dark pigment stretches as a broad band behind the collar, a gap intervening between it and the edge of the fold behind, such probably representing a sensory groove, and its borders have

the specially modified cells. Von Drasche* figures the pigment only behind the collar, and his "ganglion" is small and considerably in front of the collar, thus diverging from the condition described here. Zürcher does not deal with this region.

In longitudinal sections a marked feature is the pennate condition of the hypoderm of the anterior region—that is, between the first and second dissepiments, as well as a little in front of the former in certain cases: and it appears to be specially developed on the dorsum. The hypoderm is there thrown into a series of ridges, which in section present a streaked granular basal region terminating externally in a pennate and symmetrical series of small granular cells, after the manner of the barbs of a feather (Pl. IX. fig. 20), the breadth of the ridge varying, whilst the processes (in section) increase in size from behind forward, culminating in the collar with the deep groove in front (Pl. XI. fig. 16, and Pl. VIII. fig. 18). Some of the ridges, springing from the continuous base, are narrow distally, so that the lateral rows of cells are close on the midrib and a few are more or less conical. The transition from the hypoderm of the succeeding segment is by a gradual modification in the arrangement of the vertical cells, which by-and-by are fan-like and then pennate. This pennate condition in the preparations of the hypoderm is apparently limited in distribution, since it is absent in most sections both dorsally and ventrally, and Von Drasche neither mentions nor figures it. Moreover, in transverse sections, so far as observed, it is not seen, and therefore may be due to the arrangement of the cells in a vertical plane after preparation. An approach to this condition of the hypodermic cells is observed in some longitudinal sections of *Myxicola*, but it is less distinct than in *Owenia*, and is probably due likewise to the effect of the preservative fluid acting on a thick glandular hypoderm. The inner edge of the collar has a series of minute cells along its anterior border, and a fan-like series of strands and cells posteriorly, whilst the tip is symmetrically pennate. The anterior curve of the furrow is furnished with a special series of granular pigmented cells, *oc.*, closely arranged at the surface, and which probably have the functions of eyes. They extend the whole length of the collar from side to side on the dorsal surface, and are partly protected by that fold (Pl. VIII. fig. 18, and Pl. XI. fig. 16).

The mucous glands (*mg.*) present either a characteristic

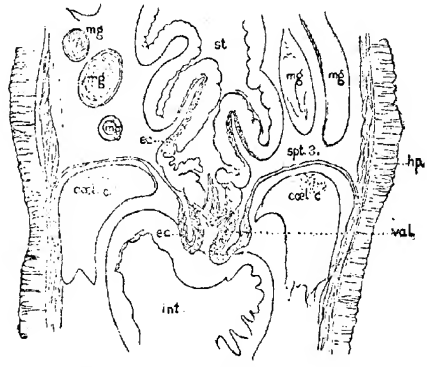
* *Op. cit.* Taf. i. fig. 3.

pennate aspect in longitudinal section or a series of straight or curved transverse bars, according as the long tube is cut in a median or lateral plane (Pl. X. fig. 19). In the former case a central axis of the secretion is flanked on either side by a series of plates, often slanting distally, and containing an occasional nucleated cell or a series of granules in the plate. Such a condition may be due to the action of the preservative spirit, or to the method of secretion, but it is worthy of note. The slender posterior ends of these glands are curved forward and outward. The secretion forms a lining to the tube, and attaches foreign structures such as sand-particles and foraminifera to it externally; and in many cases, so firmly do the annelids adhere to it after preservation, that rupture of the tissues accompanies their removal.

The hypoderm covering the mouth and buccal region, including the "lip-organ," differs from that on the surface of the body and branchiæ. It is bounded by a uniform and definite investment, and has a finely-granular and fibrillar structure, so that it forms a tougher, more massive, and more consistent layer, which, however, at certain parts diminishes in thickness as it approaches the branchiæ. It rests on a basement-layer having beneath it a complex series of muscular fibres. The same kind of hypoderm dips down and envelops the lip-organ, though it is more translucent in section, from the paucity of granules which stain more deeply. Then the organ forms a deep furrow (Pl. VII. fig. 6) with massive pale walls, whilst a double fold which now appears to the inner side, as well as the folds dorsad of the mouth, stain distinctly, as also do all the folds of the mouth and pharynx. The pale region thus lies in the figure between *a* and *a* in the centre of the organ, but it thins off on each side—that is to say, the middle region of the fold has thickest walls. The buccal mucous membrane is like that first mentioned in the lateral area of the cephalic region, viz., closely fibrous and granular, and it continues to the second diaphragm. It rests on a basement-membrane and a firm outer layer of both circular and longitudinal muscular fibres, the anterior or buccal region having numerous trabeculæ fixing it to the body-wall; and this is specially marked at the thick pale folds (lip-organ, *lp.*, in the various figures). The anterior buccal region is probably capable of partial protrusion. In front of the second diaphragm the folds of the canal have thick muscular walls, so that a certain amount of differentiation exists—either as proventriculus or stomach. Behind the second dissepiment the walls of the canal are

apparently uniform, and contain mud rich in organic remains.

The former or stomachal region enters the following or intestinal region by an aperture which is thrust backward as a cone. Moreover, the walls of the organ undergo a structural differentiation, for a short distance before reaching the aperture (text-fig.) they become finely reticulated and dotted as if formed of muscular or erectile tissue (*ec.*), whilst the lining of the tube consists of the same mucous membrane as in front. Further, the adjoining circular fold of the diaphragm (*spt.* 3) is provided with a similar, though thinner, layer of the same tissue (*ec.*), which likewise



Longitudinal section of the alimentary apparatus at the third septum, *spt.* 3, showing traces of the special muscular layer, *ec.*, enveloping the posterior wall of the stomach and its sinuses, and continued over the valvular region, *val.*; *hp.*, hypoderm; *cœl.c.*, cœlomic corpuscles; *mg.*, mucous glands.

occurs in two of the folds of the organ in front of the foregoing. This tissue is apparently muscular, and its minute structure is interesting as showing the peculiar muscle-cells with their granular contents and nuclei which stud the free border of the muscle. Zürcher * has given a good description and figures of the structure of this tissue. It evidently controls not only the wall of the canal but the blood-sinus on its outer surface, and thus may have considerable effect on the main trunks proceeding forward to the branchiæ. The cœlomic corpuscles often form a

* *Op. cit.* p. 203, and figs. 33 & 35.

translucent mass (*cœl.c.*) behind the diaphragm and on each side of the gut.

Myriochele, the second genus of the Ammocharidæ, differs from *Owenia* in the simplicity of its anterior end, for it is broadly truncated, with a smooth margin, a deep pit or vestibule leading to the mouth, and a ventral fissure; yet it is found that, though the branchiæ are absent, the nervous system is formed much on the same plan as that of *Owenia*. *Myriochele* is even more broadly truncate than *Owenia*, and as a transparent object its large blood-vessels in front and the great longitudinal mucous glands which follow give the body a striped aspect.

The cilia covering the large funnel-shaped oral cavity of *Myriochele* are long and powerful, so that the currents they cause are probably considerable. Moreover, the oral aperture is oblique, the rim dipping backward to the notch at the ventral border, thus somewhat resembling the condition in the young of *Owenia*, though the oral gap is larger.

In the early sections of the snout of *Myriochele* the hypoderm presents more distinct elements than in *Owenia*, and it appears to be somewhat thicker, its minute cells and granules in the gelatinous matrix being conspicuous. The sections have a horseshoe-shaped appearance, the wide oral gap beneath forming the heel of the shoe, which, however, is tapered at the tip, the wall thinning off at each side. The exterior of the shoe has cuticle, glandular hypoderm, and basement-tissue resting on a gelatinoid layer which has numerous minute nucleated cells along both outer and inner borders. Basement-tissue, again, bounds the vestibular hypoderm on the inner border, which differs from that of the outer wall in having a distinct inner coat, from which cilia probably spring. The basement-layer in both cases is apparently elastic. The surface-layer of hypoderm often presents clear spaces or vacuoles—probably from rupture and extrusion of the glandular tissue. Moreover, its external surface forms a more definite cuticle, whilst its inner border rests on the basement-layer, no nervous belt appearing in the first sections; but circular fibres occur within the basement-layer, and then a well-developed longitudinal coat of muscle which stretches downward to the oral edge, from which the epithelium of the mouth passes inward (Pl. XI. fig. 22) as a thick layer of cylindrical cells with nuclei, bounded internally by a thin sheet of circular fibres and a few longitudinal strands. The space (cœlom) between the body-wall and the oral wall shows many

granular cells with fine connective-tissue fibres at certain parts, besides blood-vessels. Then a narrow pale belt becomes distinct within the circular fibres and basement-tissue of the oral wall, apparently corresponding to the pale sensory layer of *Owenia* in the same region. The nerve-centre appears as a narrow pale granular band in section at the inner border of the hypoderm of the body-wall, and stretching downward from the dorsum (Pl. XI. fig. 22) as it passes by-and-by into the trunks connecting it with the ventral cord. This region therefore represents the prostomium, though devoid of any external indication. The minuteness of the nerve-centre in comparison with that of *Owenia* renders its finer details obscure, and it is more transparent. No fine strands from the hypoderm could be made out, the slightly prominent cells and interstitial tissue alone appearing at the edge, whilst its inner border rested on a smooth basement-tissue. Its position and extent agree with that in *Owenia*.

In horizontal (longitudinal) sections the central nervous system appears as an area at the inner border of the hypoderm about the point of the V-shaped oral funnel (Pl. XI. fig. 23), and its transverse breadth is shown by its appearing on each side in these sections. So far as can be ascertained in the preparations, no special sensory apparatus is present either in the form of a groove or deposit of pigment in the body-wall, but the pigment may have been removed by long preservation in spirit. Therein it differs from *Owenia* with its pigmented cells and its groove.

Then, the hypoderm, again, extends over the whole depth to the basement-layer dorsally, and the nerve-cords are differentiated laterally—at first high up, nearly on a level with the dorsal arch of the mouth (Pl. XI. fig. 25), and then gradually descending as in *Owenia*. Very soon between the mid-dorsal and the oral walls a blood-vessel appears, and one in each lateral space, the connective-tissue strands and cells which connect the walls apparently keeping them more or less in position, the vessels being proportionally large for the size of the annelid and perhaps subserving respiration (Pl. XI. fig. 25 and Pl. XII. fig. 24, *bv.*). When the body-wall becomes continuous—that is, just behind the ventral (oral) slit—the cords have reached the commencement of the lower third of the body-wall, and the median arch dorsally and the mid-lateral regions of the gullet present the thickest layer of cells, the upper angles and the lower edges being thinner. Moreover, a section of

the lip-organ (*lp.*) appears. A pale band indicates a differentiation outside the cellular layer dorsally and another laterally. The chamber by-and-by assumes a figure-of-8 outline, the section of the lip-organ occurring in the lower division; and this shows a dorsal lenticular region of firm pale nucleated cells, somewhat symmetrically arranged, the lower part still having its cavity surrounded by the softer and more deeply-stained nucleated cells of the vestibule (Pl. XI. fig. 26). The figure-of-8 outline of the chamber is now complicated by a median process on each side and by the appearance of a diverticulum (gullet) dorsally, whilst the increase in its size diminishes the space between it and the body-wall laterally and superiorly, though from the first it clings to that wall ventrally. The pale streaked dorsal region of the lip-organ is gradually increasing in size as the sections pass backward; the diverticulum joins the upper region of the canal, which is soon separated from the lower by the junction of the median processes or isthmuses, thus confining the lip-organ to a special chamber (Pl. XII. fig. 27). The upper chamber is lined by the soft cellular mucous coat; the lower has a thin lining of epithelium, with longitudinal and a few circular muscular fibres externally, the whole becoming continuous with the upper edge of the lip-organ on each side, the remains of the ventral wall with its mucous lining at first linking it to the lip-organ and then disappearing, the mid-ventral region being occupied by strong muscular fibres, probably the protractor of the organ. The nerve-cords are on each side and widely separated, and the ventral wall of the body is very thin. A blood-vessel lies on each side at the upper edge of the lower chamber; a section of a succeeding part of the canal appears at the upper border of the wall of the lower chamber, and soon stretches across the entire region. A change is also taking place in the upper chamber, the lower region of which is thickened and its cells rendered paler. In the roof of the lower chamber the cells are assuming the chordoid condition of those in the lower region, so that very soon both halves make an efficient organ for compression or manipulation. The upper chamber becomes also smaller, and the space between the two larger. Strong muscular fasciculæ appear both dorsally and ventrally over the lingual organ in the lower chamber; and the nuclei in the elongated cells of the modified organ form a row nearer the outer than the inner border. In the interval between the upper and lower chambers another diverticulum of the upper chamber has

been intruding, and is easily recognized by the numerous nuclei. The halves of the lip-organ in the lower chamber are becoming continuous and, fusing, form a dense cylinder with only a chink in the centre, the nuclei of the cells being situated near the external border. The alimentary canal in the upper region occupies more than half the area within the body-wall. At this level the hypoderm is thickest laterally and has increased ventrally with the downward progress of the nerve-cords, the lip-organ is now solid in section and smaller, whilst the canal above has increased in size, and a central chamber of different cellular structure makes its appearance, whilst by-and-by only muscular fibres occupy the place of the lip-organ inferiorly, and a cœlomic space occurs at each side. The nerve-cords touch and soon fuse.

The alimentary canal now takes a median position in the body-cavity, with a dorsal and a ventral mesentery, and it occupies a large space. The thinning of the dorsal longitudinal muscles in the mid-lateral region indicates a differentiation, whilst a considerable mass over the ventral nerve-cord and a thinner layer on each side represent the longitudinal ventral muscles. The mucous glands now appear toward the lower region of the cœlom, and they seem to have the same structure (Pl. XII. fig. 28) as in *Owenia*, and to open by similar wide ducts. The dorsal and ventral blood-vessels in the respective mesenteries are large. The hypoderm at this level is thick all round, especially ventrally, where the nerve-cords are in juxtaposition, and the dorsal and ventral longitudinal muscles are thicker and better differentiated (Pl. XII. fig. 29). The alimentary canal next presents various wrinkles; and a pale band passes from each side of the nerve-cords (which are proportionally large) outside the basement-layer, as if extension were indicated. The alimentary canal is thrown into deep folds, as if a stomachal or gizzard-like part existed in the lateral regions, whilst the dorsal and ventral arches have the ordinary mucous structure; then considerable vertical constriction occurs, the dorsal and ventral arches disappear, and a vascular sinus is established laterally. Thereafter the gut is pointed above and is split into two lobes ventrally, with muscular bundles in the gap. The latter (gap) by-and-by disappears, the canal enlarges, the lumen is much filled up with the dense coating of cells, and the vascular sinus around it is continuous in the sections (Pl. X. fig. 30). Externally at this level the hypoderm is massive ventrally, thins off laterally, and again becomes thin dorsally. The longitudinal muscular coat is thinner, and fibres radiate from a little

above the duct of a mucous gland, impinging on the wall of the blood-sinus on one side, and apparently attached to the depression in the hypoderm and indicative of an opening in the mid-lateral region. The epithelium in the food-canal differs quite from that in front, being almost fibro-granular in aspect from the elongation of the cells, the nuclei of which lie toward the outer border, and at first the surface presents reticulations. The alimentary canal enlarges behind the foregoing, but the character of the mucous lining remains the same, and the ventral blood-vessel lies in the mesentery over the nerve-cord, which is large, with a median peak dorsally and a specially thickened hypodermic layer at each side. On the dorso-lateral regions of the body the hypoderm appears to be thicker than on the mid-dorsal and mid-lateral parts. No specialized dorsal blood-vessel appears in this region, for it has fused with the sinus.

In horizontal longitudinal section (Pl. XI. fig. 23) the alimentary apparatus has a similar appearance at the second septum to that shown in *Owenia*, though the details are slightly different and the scale is much less. The mucous lining is thickened as it approaches the septum, and a centro-lateral fold bulges forward into the stomachal or gizzard-like division, whilst the central opening is narrowed and enters the succeeding part of the alimentary canal as a prominent papilla. The narrow termination of this region stains more deeply than the rest; indeed, it is coloured like the muscular septum, so that it is probable that it has specially developed muscular fibres at this part so as to enable it to perform sphincter-like functions, the food being retained in this chamber for some time and then permitted to pass backward by relaxation of the muscular guard.

In vertical sections of the middle region the gut is at first flask-shaped, the wide part, with the contents, being dorsal, the narrow part ventral; and the mucous lining has again altered its character, the cells being larger, their nuclei larger, and the inner edge smooth. The cœlomic space in the female is distended on both sides with large ova having a clear nucleus, an opaque nucleolus, and granular contents, and they spring from the epithelium of the mesentery below the ventral blood-vessel, the smaller ova being inferior, the larger superior. A noteworthy change is the disappearance of the blood-sinus around the gut and the presence of a dorsal vessel in the upper mesentery, the ventral trunk remaining as before. The thick layer of hypoderm ventrally has a furrow over the median nerve-cord, and this coat is comparatively thin laterally and dorsally. The dorsal and

ventral mesenteries separate the muscles of the sides, but there is little to distinguish between the areas of the dorsal and the ventral muscles respectively.

Proceeding backward the epithelium of the gut becomes somewhat finer, the longitudinal muscles form a uniform layer all round without evident differentiation other than the attachment of the median mesenteries, and the hypoderm still remains thicker ventrally, whilst the blood-vessels and ova show no change. A gelatinoid (protoplasmic) layer envelops the longitudinal muscles internally, the representative of the cœlomic epithelial layer.

Then the intestine in section shows a keel ventrally, and septal strands, apparently muscular, pass from it to the body-wall, making membranous (and partly muscular) septa to the latter, viz., one on each side of the gut. These septa, however, soon reach the dorsal region and become attached to a process from the dorsal wall of the gut on each side, the dilated (globular) region of the canal being filled with food below these, the ventral portion forming a solid apex. The septa tend to mount upward on the interior of the body-wall, leaving two great areas ventrally on each side of the canal and a narrow dorsal chamber above the septa. Finally, the septum disappears, leaving only a small vessel at the dorsal mesentery. Then a sinus again forms on the upper wall of the gut, the ova continue as in front, and the section of the nerve-cord is more or less circular.

Behind the former region the body-wall becomes somewhat thinner, the thickest region of the areolated hypoderm being the ventral. The nerve-area is comparatively large and ovoid. The basement-layer and, it may be, fine circular fibres occur internally, whilst the longitudinal muscular fibres are only differentiated by the median mesenteries dorsally and ventrally. The gut is large, with a firm external wall and a single layer of cylindrical epithelium, the nuclei being symmetrically arranged in the middle. No dorsal vessel is visible, but the frilled external wall of a sinus occurs laterally on the intestine. The ventral blood-vessel is large and the mesentery leading to the ventral wall is loaded on each side with developing ova, the larger forms distending the cœlomic cavity on each side (Pl. IX. fig. 31).

The tip of the tail is bilobed, with, in addition, a ventral median semicircular lobe, and is richly ciliated (Pl. X. fig. 32), a short terminal portion of the intestine being straight, the next (in front) being indicated by a slight constriction, whilst the third is almost elliptical, from marked constrictions in front and rear. In most cases, when removed from the

tubes after preservation, the caudal region is thrown into various zig-zags or spirals, and the tufts of bristles are more conspicuous than in front. One or two of the terminal bristles are single on each side, those preceding being in groups of two, three, four, and five or more. In certain examples, in lateral view, the ventral process at the tip of the tail projects more than the dorsal, though, perhaps, irregularity of the dorsal lobes occasionally occurs. The arrangement of the septa is apparently on a similar plan to that in *Owenia*, where they are very distinct. The septa in *Myriochele* probably cause the constrictions, and the tips of the lozenge-shaped sections of the intestine are fixed by membranous attachments to the body-wall. A pinnate aspect is apparently due to the blood collecting at the septa, where it was darkened by the stain (hæmatoxylin). The reproductive elements appear to be lodged on each side posteriorly, but their mode of exit has not been demonstrated. So far as could be made out, no pores were present posteriorly.

In sagittal sections of the tail (Pl. X. fig. 33) the constriction present a short distance from the tip appears to be normal, the gut being narrowed at this point and furnished with a valvular process projecting forward (*val.p.*). The terminal region of the body thus marked off is divided dorsally into five compartments by short transverse septa, on the anterior faces of which layers of blood occur, probably from extravasation, as no walls other than the septa are visible. The continuation of comparatively large intestinal sinuses almost to the tip of the tail, in addition to the ventral trunk, indicates their importance in the economy of the annelid, probably in connection with a respiratory function.

The transverse sections of the extreme tip of the tail show a ring of hypoderm with a ventral gap (Pl. X. fig. 34), on each side of which the wall is thickened, so that it is lobate. Moreover, a differentiation occurs in this lobate part, as if an aperture existed; but such may be due simply to the more vacuolated condition of the hypoderm of this region. The cells are larger than on the dorsal surface, and after the completion of the posterior aperture they form a distinct pale area on each side of the middle line (Pl. X. fig. 35). The gut shows, almost before its closure, traces of the vascular sinus (Pl. X. fig. 35, *vs.*) on each side, the blood in which had been rendered of a deep purplish-black hue by the action of hæmatoxylin; and soon the ventral vessel appears, the lateral sinuses greatly increase in size, whilst ova are present between the ventral vessel and the body-wall, the nuclei in these being

deeply stained. The lateral sinuses leave only a small portion of the gut bare above the ventral vessel in front of the foregoing sections, and the ova occupy the lateral regions, though their position is variable, for they by-and-by appear, as the body enlarges, below the alimentary canal and the vessels.

The fine sand-tubes of this form abound in such regions as the Gulf of St. Lawrence, and occasionally one end (the caudal) is terminated by a long tapering filament of the secretion covered with sand.

The main feature in forms like the present is the partial differentiation of the nerve-tissue from the hypoderm with which it is in continuity at its centre. No sheath is evident anywhere, even in the more distinctly outlined nerve-cords posteriorly. Yet the position of the cephalic centre and its connection by two trunks with the ventral nerve-cord agree with the general type. The innervation of the alimentary canal seems to be carried out on a similar plan to that of the main system, viz., by contact with a sensitive layer rather than by special twigs, since the latter have not been met with in sections. The whole nervous apparatus, indeed, is in an elementary condition, and in marked contrast, for instance, with that of such highly differentiated types as *Bispira* and *Branchiomma*, where a chordoid skeleton protects the central ganglia and the neuroglia is much developed, the whole central system being shielded by the tissues around it, and so in the brain of *Glycera* as described by Gravier *, in various types by Eisig, and in the brain of *Lagis* as shown by Nilsson †. In *Owenia* and *Myriochele* the trunks from the central system are not œsophageal, but run externally in the hypoderm to join the ventral cord. Both *Owenia* and *Myriochele* appear to have certain larval characters, as seen in the young of various polychæts, for instance, in Kleinenberg's ‡ *Lopadorhynchus*, in which, amongst other features, the nervous system of the gullet may approach that of the enigmatical pale layer in the vestibule of the present species. The structure of *Saccocirrus*, as given by Goodrich §, also presents certain analogous conditions.

The alimentary canal of both *Owenia* and *Myriochele* shows certain valvular complexities, doubtless associated with the nature of their food—viz., mud or sandy mud containing organic particles of various kinds. Carried into the

* Bull. Sc. France et Belg. t. xxxi. p. 159.

† 'Beiträge der Kennt. des Nervensystems der Polychæten,' Upsala, 1912.

‡ 'Die Enstechung des Annel. aus der Larva von *Lopadorhynchus*,' 1886.

§ *Op. cit.*

vestibule by ciliary currents, it would in the first instance be subjected to the action of the œsophagus, then passed in certain quantities into the stomach with its mobile glandular walls, and subsequently sent through the funnel-like muscular valve at the third septum into the intestine. The occurrence, moreover, of the valve-like folds towards the posterior end of the intestine in *Myriochele*, with the adjacent vascular apparatus, would seem to indicate special functions there, both in regard to the contents of the gut and respiration.

The central nervous system in *Owenia* and *Myriochele* does not conform to the typical three regions of the able investigator Racovitza—viz., the paired "région palpaire" giving branches to the palpi, the unpaired "sincipital" giving branches to the eyes and tentacles, and the paired "nuchal" to the ciliated sensory grooves; or to those of other authors of more recent date, the elementary condition, perhaps, being associated with the feebly developed and much modified prostomium, especially in *Myriochele*. Further, the contrast between the typical form with its circumœsophageal commissures is noteworthy, since the homologues of these are as much hypodermal as the central mass, for the nervous layer beneath the hypoderm of the vestibule essentially differs.

Another feature of moment is the absence of distinct nephridia in both *Owenia* and *Myriochele*, the only representative of a tube communicating with the cœlom and the exterior being Gilson's long hypodermic tube in the sixth segment, and which apparently is indicated in Delle Chiaje's* original figure as two zig-zag tubes between two bristle-tufts; and the author was also acquainted with the long mucous glands and the general arrangement of the branchiæ and their blood-supply. The addition of two eyes to one of the figures (2), with a pair of pinnate branchiæ, is, however, more or less imaginary.

Again, the general structure of *Owenia* and *Myriochele*, as representing the family Ammocharidæ, gives small grounds for their association under the same suborder, as Prof. Benham in his earlier classifications† seemed to think, with the Spionidæ and Chætopteridæ in his group Spionoformia, which really comprehends these only, since his Polydoridæ and Magelonidæ, of which separate families are made, can without undue laxity be placed under the Spionidæ. Levinsen, indeed, had previously made a separate group for

* Discriz. e Nat. degli Anim. Invert. pl. 175. figs. 1–5 (1841).

† 'The Cambridge Natural History,' vol. ii. p. 258 (1896).

his "Ammochariformia," keeping under his "Syllidiformia Spionina" the Spionidæ, Chætopteridæ, Cirratulidæ, Ariciidæ, Chlorœmidæ (?), and Opheliidæ, an assemblage even more complex than that of Prof. Benham.

Explanation of the letters used in the figures.

br. Blood-vessels.
c. Central nervous system.
cm. Circular muscular coat.
cœ. Cœlom.
cœl.c. Cœlomic corpuscles.
dm. Dorsal longitudinal muscles.
dv. Dorsal blood-vessel.
ec. Special layer of gut and diaphragm.
g. Gonads.
hp. Hypoderm.
hpe. Thickened layer of hypoderm.
int. Intestine.
lp. Lip-organ.
m. Mouth.
mg. Mucous glands.
mp. Pore of mucous gland.
nc. Nerve-cord.
œs. Œsophagus.
ov. Ova.
spt. Septum.
st. Stomach.
val.p. Valvular process of alimentary canal.
vm. Ventral longitudinal muscles.
vs. Vascular sinus.
vv. Blood-vessels.

EXPLANATION OF THE PLATES *.

Plate VII.

Fig. 1. Transverse section of the anterior end of *Owenia fusiformis*, Della Chiaje, to show the central nervous system (*c.*). *m.*, mouth, the lining of hypoderm also having a pale band beneath it at *mc.* The ventral gap in the body-wall is still open. × Zeiss oc. 2, obj. A.

Fig. 2. More highly magnified view of the central nervous system, *c.*, as part of the hypoderm, *hp.*, *cm.* Circular muscular coat. × oc. 4, obj. D.

Fig. 3. Transverse section after the completion of the body-wall in front and the appearance of the lip-organ *lp.* *nc.*, nerve-cord. × oc. 2, obj. A.

Fig. 4. Section behind the foregoing. The vestibule is now contracting, and the lip-organ, *lp.*, is in full development, with its inner bifid region and more massive external part. × oc. 2, obj. A.

* I am indebted to the Carnegie Trust for part of these figures.

Fig. 5. The wall of the œsophagus, *œs.*, as the sections proceed backward, is completed, and various blood-vessels, *vv.*, including the dorsal trunk, *dv.*, are prominent. The lip-organ, *lp.*, presents a basal mass with a central chink, and a regular arrangement of its tissue. × oc. 2, obj. A.

Fig. 6. Vertical section of *Owenia fusiformis*. *a.*, the vestibule; *c.*, central nervous system; *lp.*, lip-organ; *mg.*, mucous gland; *spt.*, septum. The section is imperfect at *x*. × about 40 diam.

Plate VIII.

Fig. 7. Transverse section behind the folds of the lip-organ and at the point where the tendinous transverse band, *bt.*, and its lateral connections occur in the ventral region. × oc. 2, obj. A.

Fig. 7 A. Transverse section indicating the condition of the parts of the lozenge-shaped tendinous region ventrally, as its upper and outer edges differentiate into muscular fibres and strands pass into the fasciculi beneath. × oc. 2, obj. A.

Fig. 8. Transverse section behind the foregoing, showing the diminishing, pale, elastic band, *bt.*, and the complete condition of the ventral longitudinal muscles, *vm.* The stomachal region is surrounded by blood-vessels, *bv.* × oc. 2, obj. A.

Fig. 9. Section in the line of the bristle-tufts with the opening of the mucous gland, *mp.* The stomach is still surrounded by the various vessels and their mesenteries. A trace of the elastic system is seen in the muscular differentiation, *mc.*, of the mid-ventral area. × oc. 2, obj. A.

Fig. 10. The thickening of the dorsal and ventral walls of the stomach is conspicuous in this section (behind fig. 9). On the left is a bristle-tuft, *br.* The median dorsal and ventral blood-vessels and their mesenteries, and the ducts of the mucous glands are seen on the way to the anterior. × oc. 2, obj. A.

Fig. 18. Vertical section of the region of the collar, *col.*, and the central nervous system, *c.*, with the adjoining body-wall. × oc. 4, obj. D, with 2-inch draw-tube.

Plate IX.

Fig. 11. The body-wall has attained its general arrangement with the exception of the thickened lateral portions of hypoderm, *hpc.* The cœlomic space is large, and the median dorsal mesentery is split inferiorly. The nerve-cords have now fused. × oc. 2, obj. A.

Fig. 12. In this section, which is posterior to the preceding, the vertical elongation of the alimentary canal is noteworthy, and the accompanying vessels are still separate, though in some fusion is indicated. The cœlom has its corpuscles, and the mucous glands and their ducts are distinct. × oc. 2, obj. A.

Fig. 13. Transverse section after a considerable interval backward from the foregoing, showing the great extent of the ventral longitudinal muscles, *vm.*, and the commencement of the male gonads, *g.*, below the gut. The large area occupied by the intestine and its enveloping sinus is noteworthy. × oc. 2, obj. A.

Fig. 14. Section in front of the tail in a ripe male. The gut is still enveloped in the spacious sinus, *vs.*, with its dorsal and ventral mesenteries, and the cœlomic cavity is loaded with sperms. The gonads, *g.*, are large, as also is their blood-supply, *bc.*, whilst the nerve-cord is smaller than in front. The arrangement of the muscles of the body-wall diverges from that in front, since the dorsal longitudinal muscles, *dm.*, are thickened on each side of the middle line, as are also the ventral above the nerve-cord; but in the figure the parts have been separated by the methods of technique. The hooks, *u.*, occur in numbers along the whole lateral region on each side, the bristle-tufts being shifted to the dorsal aspect. × oc. 2, obj. A.

Fig. 15. Section through the characteristic arrangement of the caudal septa, *spt.*, some distance behind fig. 14. The gonads, *g.*, in this region increase in size from before backward, and the free sperms lie in the chamber above the upper septa. A transverse septum is seen below the gonads. The dorsal longitudinal muscles are thickest, whilst the ventral cover two-thirds of the body-wall. × oc. 2, obj. A.

Fig. 20. Peculiar pennate arrangement of the gelatinous tissue and glands of the hypoderm anteriorly. × oc. 4, obj. D, with full draw-tube.

Fig. 31. Transverse section of the posterior region in a female with well-developed ova, *ov.*, which arise from the vascular ovigerous tissue ventrally, as in the male; some are cut and others altered by compression. × 100 diam.

Plate X.

Fig. 19. Longitudinal section showing the arrangement of the mucus in the mucous glands. × oc. 2, obj. 4.

Fig. 30. Section through the stomach after the blood-sinus, vs., around it is established. *mg.*, mucous gland: *bc.*, blood-vessels. The median ventral furrow, making the organ bifid in section, has now disappeared. × 100 diam.

Fig. 32. Tip of the tail of *Myriochele* protruding from a tube. Two dorsal papillæ and a slightly more prominent ventral papilla occur posteriorly. The zig-zag condition of the gut in this region is indicated. × 60 diam.

Fig. 33. Section of the tip of the tail of *Myriochele*, showing the valvular apparatus, *val.p.*, at the constriction of the body-wall, the septa, *spt.* The blood has been rendered opaque blackish by the hæmatoxylin used in the technique, and apparently has accumulated at the septa.

Fig. 34. Transverse section of the extreme tip of the tail of a female with the modified areolæ of the hypoderm, a larger area on each side being evident. × oc. 2, obj. D, with 1 inch of draw-tube.

Fig. 35. Section of the tail a little in front of the foregoing, showing the large areolæ of the hypoderm and the blood in the sinus, *vs*, around the gut. × oc. 2, obj. D, with 2-inch draw-tube.

PLATE XI.

Fig. 16. Vertical section of one half of the anterior end of *Owenia fusiformis* cutting the nerve-centre, *c.*, across, and showing its relation to the sensory groove with its pigment-corpuscles on the anterior wall, in close relation to the central nervous system. A fold of the vestibule is seen at *vt.* × oc. 2, obj. A, with 1-inch draw-tube.

Fig. 22. Transverse section a little behind the tip of the snout of *Myriochele* on the appearance of the pale central nervous system, *c.*, which becomes continuous with the nerve-cord on each side. The mottled condition of the hypoderm anteriorly is characteristic of this form. × about 100 diam.

Fig. 23. Horizontal section through the vestibule and three regions of the alimentary canal, viz., *œs.*, œsophagus, *st.*, stomach, and *int.*, intestine. *spt.*, septa; *val.*, valvular apparatus; *c.*, central nervous system; *bv.*, blood-vessels, in some cases the dark blood (coloured by hæmatoxylin) has been pushed beyond the line of the vessel. × Zeiss oc. 4, obj. A, with 1½-inch draw-tube.

Fig. 25. In this section the cords are descending, being a little below the middle line, and the sides of the vestibule are now slightly united. Dorsal and lateral blood-vessels are in a similar position to those in the foregoing figure. × 100 diam.

Fig. 26. The body-wall is completed, as also is the vestibule. The nerve-cords, *nc.*, are descending, and a section of the lip-organ, *lp.*, appears. × 100 diam.

PLATE XII.

Fig. 17. Sagittal section of the anterior end, to illustrate the complex interlacing of the muscular fibres. The collar, *col.*, and central nervous system, *c.*, are seen on the left. × oc. 2, obj. A, with 1-inch draw-tube.

Fig. 24. Transverse section before the completion of the body-wall. The nerve-centre, *c.*, is well shown, and probably the lower ends represent the commencement of the nerve-cords. Blood-vessels, *bv.*, occur both dorsally and laterally. × 100 diam.

Fig. 27. In this section the outline of the body is slightly altered, the vertical exceeding the transverse diameter. *œs.*, œsophagus with its cellular lining; *lp.*, lip-organ and its radiate arrangement of cells; *br.*, blood-vessels. The dorsal and ventral portions of the walls are much attenuated, partly from stretching. × 100 diam.

Fig. 28. The diminution of the dorsal hypoderm and the increase of the ventral hypoderm are indicated in this figure, together with the great size of the œsophagus. The nerve-cords are approaching each other. × 100 diam.

Fig. 29. Transverse section after the union of the nerve-cords, *nc.* The succeeding region of the canal is joining the œsophagus on the right, and two mucous glands, *mg.*, are cut obliquely. × 100 diam.

XX. — *Notes on Exotic* Helomyzidæ, Sciomyzidæ, *and* Psilidæ. By C. G. Lamb, M.A., B.Sc., Clare College, Cambridge.

Helomyzidæ.

Helomyza, Fall.

In the Wiener Ent. Zeit. for 1901 Czerny critically examined all the species of this genus up to that date; since then only about half a dozen species have been added, and hence the task of working out the specimens in the collections was much simplified. There was one well-known species and three new ones, one of the latter being very interesting as departing from the almost universal character of having extra costal bristles.

Helomyza picta, Wied.

S. Rhodesia: Chirinda Forest (*G. A. K. Marshall*, Camb. Coll.).

There was a fair series of this handsome insect. It exhibits considerable sexual dimorphism. The sex described is the male, and it has the dorsum elegantly variegated in ochre and dark ochreous grey; its femora are beautifully and regularly spindle-shaped, the mid pair less so, and they bear long dense hairs below. The female has a quite dark dull brown dorsum and scutellum, which exhibit only faint signs of the male marks; the femora are normal, less haired, and the front ones have an anterior spine row—in fact, the sexual differences in the legs are like those of some *Scatophagas*. This type of *Helomyza* is devoid of the upper patches carrying the orbital bristles, and also of the small ocellar triangle joined to these, which are usual in the European forms; it has also pictured wings and swollen and hairy male femora; this form seems to be typically African. Speiser, in his Kilimandjaro-Meru Expedition paper, describes two males of the same facies—*H. aeroleuca* and *H. lacinata*—and the next species also belongs to this section.

Helomyza ingens, sp. n.

A single male of the *picta* group was present; it is larger and more stoutly built than that species.

Head (top view):—Frons and antennæ entirely yellow to orange, in front a little darker, with microscopic hairs and

irregular reddish patches, but with no sign of dark or blackened spots except the usual hairy neck-spot, an excessively faint large spot behind the vibrissa, and the brownish-red ocellar spot; the antenna has a darkish flagellum with very long hairs, and the third joint has its absolute ridge red. Side-view:—Jowls, palpi, tongue (also the face) all yellow; hind head and lower side bristly as usual; vibrissa very strong; eyes rather rectangularly oval, with long axis vertical; jowls about as deep as breadth of third joint of antenna.

Thorax: dorsum dull dark coffee-brown, except the much lighter callus and front of dorsum; the light part quickly merges into the dark just as the true dorsum begins; two dark lines start near the neck, and continue right over the dorsum, but are necessarily very faint on the dark part; between them, and also along the d. c. lines, are two faint narrow lines showing up more ochreous than the rest. Scutellum flat, slightly shining, quite bare, with a few tiny ridge-hairs between end- and side-bristles. All the macrochætes are long, but slender for the size of the insect; side above the notopleural suture from the callus rather brown and shining, below the pleura is as dark as dorsum, though a little more shining; mesopleura absolutely bare; metanotum dull, more grey; all bristles normal.

Wings darkened, the costal bristles stout and about fifteen in number from end of vein 1, ceasing about level of hind cross-vein. The general colour of the wing is brown; from the end of 1 to the tip a darker brown covers the wing up to about the middle of the cubital cell; the distal part of this extra darkening extends across the wing; the basal parts of veins 3 and 4 are included in another darkened area, the small cross-vein and neighbouring parts of 3 and 4 in another, and the hind cross-vein and near parts of 3 in yet another; there are clear "windows" between the veins at the base, and the usual "window" just distal of the anal cell shows very brightly; the absolute costa between ends of 2 and 4 is pale ochreous, but otherwise all the veins are brown. Halteres clear white.

Legs: femora all elegantly spindled, mid less so than others, with long profuse blackish hairs at sides and below. Colour: all coxæ and trochanters orange, more or less darkened, all femora shining black, all tibiæ orange, front with black tip, hind suffused; all with long hairs below, which are excessively long on distal half of middle tibia; all tarsi orange, the last joints dark and first joint of middle one with very long hairs. Bristles:—front femur a superior row of about 7,

tibia with a distal anterior row of 3; mid tibia with crown of about 4, the inner very long; hind femur with irregular rows anteriorly totalling 10 to 12 bristles; all tibiæ with usual preapicals, hind ones with small inner spur.

Abdomen pitchy black, except at the scutellar angles of the first segment; hypopygium not large, very hairy.

Size 8¼ mm.

British E. Africa: Kenia Forest (*T. J. Anderson*, Imp. Bur. Ent.).

The following species are of the normal European form, with well-marked upper vertical patches and ocellar triangle, and with simple legs. Both belong to the section with long-haired arista and quite bare mesopleura.

Helomyza balteata, sp. n.

Head (top view):—Frons dullish orange and hairy, brighter and bare in narrow lines on each side of the ocellar triangle and along a mid line to the front; the upper vertical patches and the ocellar triangle sharply bounded, grey, the former with a pointed tip and only touching eyes just on vertex; hind head orange, with well-marked trapezoidal spot from neck to vertex; all bristles normal. Face smooth, orange. Side view:—Eyes rather elongate-oval, with the long axis in the line joining outer vertical to the protuberant mouth-angle; the latter is covered with a large dark patch, the rest of face &c. being orange; antenna orange, arista black, with long and strong pectination, stout slightly orange basal joints; long vibrissa with a small companion below; depth of jowl about equal to breadth of third joint; hind head orange and bristly. Palpi orange, with slightly infuscate tip; tongue orange.

Thorax: dorsum almost uniformly dull ochreous brown, the tiny black bristles looking like a close regular punctation; a very faint pair of median lines between the d. c. bristles, which stand on brown spots; callus grey; scutellum as thorax, but a little paler centrally on disc and on the absolute tip, quite bare and flat, with a few tiny hairs between main bristles; pleura orange above, merging to yellow below, dull; mesopleura quite bare; metanotum dark, somewhat shining orange.

Wing with about nine stout spines from end of vein 1 to about level of hind cross-vein; suffused, the darkening being more intense from costa to just over second vein; both cross-

veins well and broadly suffused ; veins brown. Halteres orange.

Legs : colour all orange, except that the hind knees and all the last tarsal joints are brown, and the tibiæ have tips browned. Bristles :—front femur with usual upper row and inferior hairs ; mid femur with anterior row of 3 on distal third ; hind femur with 5 bristles, three form an anterior superior row, the last of these and two others, one above the other, form a triangle ; usual tibial preapicals.

Abdomen orange, each segment with a black band based on distal margin, narrow at side and broadening to middle, with rather indistinct boundary there, so that the appearance is like an indistinct mid-line with distinct side-teeth ; genital segment orange, except extreme tip, which is black.

Size 7 mm.

S. RHODESIA : Chirinda Forest (*G. A. K. Marshall*, Camb. Coll.).

Helomyza aspinosa, sp. n.

This large species is quite aberrant, inasmuch as the characteristic costal spines are not to be seen ; they are apparently so short as to merge in the general costal bristle-border, which is more strongly developed than usual. The venation is quite normal, as is the complete chætotaxy in every respect. In broad facies the insect is not quite typical of the genus, but looks rather like a Dryomyzid. The absence of costal bristles is even more marked than is apparently the case in the aberrant genus *Thyreophorella*, if one may judge by the figure of the same.

Head (top view) :—All dull orange, darkened a little in front, black-haired, especially in front ; the usual short hind eye-borders and conjoined ocellar triangle are somewhat paler, as is the hind head ; the neck-spot is more orange and a little silvery. Face orange, a little darker over lip. Side-view :—All orange, including the antennal third joint (which is, however, brown on its absolute edge), arista (with very long hairs), the hairy palpi, and the tongue ; a long vibrissa, with a few short neighbours below.

Thorax : dorsum dull reddish brown, a little darker in front and lighter on side from d. c. lines to pleura ; two indistinct blackened lines run along the d. c. rows, with a similar indistinct line outside from about the level of cross-suture. Scutellum similar on the disc, which is quite flat and bare, with a few tiny hairs between the main bristles along the edge. Pleura (including callus and notopleura)

brightish orange, as are the sides of the scutellum and the metanotum; a darkened stripe runs from the end of the callus to the wing-base; the mesopleura is absolutely bare.

Wings quite normal, except as described above, somewhat suffused, especially costally; veins brown, more orange at base.

Legs normal. Colour: all yellow, except for tiny side-spots on the tips of middle and hind femora; front and hind tarsi with all joints suffused, middle with last joint black. Bristles: front femur with dorsal row of 6 and hairy below, middle femur with anterior row of 3 or 4, shaggy below, tibia with a crown and shaggy below; hind femur with superior row of 4 on distal half, rather haired below; all tibiæ with usual preapical.

Abdomen pitchy black, with basal segment more orange, sides of all segments (except the last) and the venter orange, genital segment black; all segments with border-bristles, very long on the sides.

Size 9½, wing 8½ mm.

S. Rhodesia: Chirinda Forest (*G. A. K. Marshall*, Camb. Coll.).

Sciomyzidæ.

Sepedon, Latr.

In the Ann. Mus. Nat. Hong. vol. ix. (1911) p. 266, Hendel published a paper on this genus, bringing the species from Asia and Africa up to date; since then only one species has been added. The paper is conservative in treatment, and clears up the confusion existent in the species as well as may be. No references are given here, as the above paper is used in what follows.

Sepedon violaceus, Hend.

India: Coimbatore.

Sepedon lobiferus, Hend.

A nice series of this interesting form was in the Cam. Coll. under the name *javanicus*, R. D. The insect was hitherto only known from Formosa, and its occurrence in the Himalayan district is of interest.

India: Showali, Kumaon.

There are two species in the Cam. Coll. from Africa. Speiser, in his paper on the Kilimandjaro-Meru Expedition (*s.* 5, pp. 168, 169), describes the species *trichooscelis* and *argyrostethus*; Hendel considers that the former is a synonym of *ornatifrons*, Adams, the latter most probably of *senegalensis*, Macq.; the author had independently come to the same conclusion. Both of Speiser's species were founded on single damaged specimens, and in the case of this genus that procedure is especially hazardous.

Sepedon ornatifrons, Adams.

A fair series is in the Camb. Coll., showing quite perceptible degrees of variation.

S. Rhodesia: Chirinda Forest (*G. A. K. Marshall*, Camb. Coll.).

Sepedon senegalensis, Macq.

Natal: Durban (*F. Muir*, Camb. Coll.).

Psilidæ.

Chyliza, Fall.

There are two specimens from Ceylon which do not agree with any of the known Oriental species; in general appearance they are very like *C. leptogaster*.

Chyliza pallidipes, sp. n.

Head (top view):—The eye-borders black and somewhat shining, about $\frac{1}{4}$ of total frontal width, extending from vertex nearly to front, but narrowing sharply in front; the wider part of the frons lying between these anterior narrowed parts is bright but dull yellow, the rest is brown ochreous, but the long ocellar triangle is a little shining and its base and the absolute vertex are rather shining orange; the whole head is covered with tiny golden pubescence; the bristles as in *C. leptogaster*, but stouter in proportion. Face yellow, but the lower half of the antennal pit is shining black; the narrow lower eye-margins slightly silvery. Side view:—Antenna with deep black basal joints and orange third, which is just perceptibly suffused on its edge; arista pale brown, with widely bipectinate flagellum, the total breadth of the pectination being about equal to the breadth of third; palpi deep black, tongue yellow. Hind head entirely shining

black above, black below, but widely bordered with yellow, so that hind jowls and mouth-margin are all that colour; eyes like *C. leptogaster*, with sinuate hind margin.

Thorax: dorsum subshining black, with uniform shallow minute shagreening; entirely covered with elegant pale yellow hairs, except for two lines, confluent in front and abbreviated about halfway, which are bare (these are best seen with oblique light); the dorsum is much like *leptogaster*. Pleura like the dorsum in front, but with silvery white hairs, longest below; the sclerites over the hind leg are all smooth, hairless, and very shining; just over the callus is a rather bright orange narrow bar, and a dark orange one is just visible on the top of the sternopleura. Scutellum all rather shining orange, bristled as in *leptogaster*.

Wings slightly smoky, especially broadly so at tip between costa and vein 4; the latter is parallel to 5 up to about its distal fifth, when it makes a sudden slight bend upwards; veins brown, extreme base of wing orange. Haltere with snow-white head and slightly brownish stalk.

Legs all pale straw-coloured, a little whiter proximally on the femora, with no sign of any rings or darkening.

Abdomen like the thorax in colour and punctation, but the hairs are brownish; the shape is more wasp-like than in *leptogaster*.

Size 5 mm.

Ceylon: Peradeniya (*A. Rutherford*, Imp. Bur. Ent.).

Loxocera, Mg.

In the Kilimandjaro-Meru Expedition Reports (x. 5, p. 193) Speiser gives a table of the known African members of this genus. Of these, *L. dispar*, Bezzi, is apparently quite distinct, having a black triangle, sternopleura, and front femora. He separates the others on the presence or absence of thoracic stripes and their position: thus, *L. rufa*, Loëw, is given as stripeless, *L. lateralis*, Lw., and *L. macrogramma*, Speiser, are striped in different ways.

In the Camb. Coll. are eleven specimens of a red *Loxocera* of the latter group. They are evidently closely related, and, apart from thoracic marks, differ only in the degree of undulation of the fourth vein between the cross-veins, and the angle between the last cross-vein and the fifth; in such cases where the veins are wavy or bent (as is the cross-vein here concerned) the angle in question and the amount of curvature of the veins is always a little uncertain. Apart from this and the colour of the thorax, neither of which are correlated

with one another nor with the sex, no structural difference is apparent. Now the thoracic dorsum varies greatly; of the seven males, one is clear red (typical *rufa*), one has side-lines just in front of the scutellum, one has side-lines complete but no middle one (this is typical *macrogramma* by comparison with Speiser's full description), one has side-lines and a faint middle one in front, one has all these lines well marked, one has all the lines broad and even confluent at the middle of the disc, and another has the lines reddish but a little dark behind. Of the four females, one is quite immaculate, one has only the faintest trace of the lines in red, one has the lines all present but faint, the last has all present and very strong. The author is quite sure that Speiser's *macrogramma* is a dark-lined form of *rufa*. As regards the two species of Loëw (*rufa* and *lateralis*), some doubt may arise. Loëw evidently had single specimens only (*rufa* is described from a ♀, *lateralis* from a ♂; see B. E. Z. 1874, xliv. p. 194). The main difference appears to be dark flecks in the antennal pits in the latter species and (possibly) less hairy arista. It is impossible to be sure of the true distinctness of these three species, and hence the author considers all the red *Loxoceras* with entirely black third joint to be *L. rufa*, Loëw.

S. Rhodesia: Salisbury and Chirinda Forest (*G. A. K. Marshall*, Camb. Coll.). Natal: Durban (*F. Muir*, Camb. Coll.).

XXI.—*Further Notes on the New Zealand Amphipod* Hyale grenfelli, *Chilton.* By Chas. Chilton, M.A., D.Sc., M.B., C.M., LL.D., C.M.Z.S., Professor of Biology, Canterbury College, New Zealand.

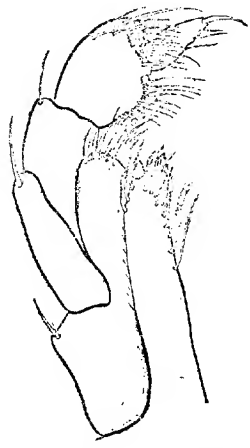
In May 1916 * I described a new species of Amphipod from New Zealand, naming it *Hyale grenfelli*. The type-specimen, which was the only specimen at that time known, was a male, and was characterized by the peculiar shape of the second gnathopod and by the great dilatation and setose character of the terminal joints of the maxillipeds. I pointed out that it was quite likely that this peculiar development of

* Ann. & Mag. Nat. Hist. ser. 8, vol. xvii. p. 362.

the maxillipeds would be found in the male only, and was probably to be looked upon as a secondary sexual character.

On December 12th, 1916, I received from Mr. C. R. Gow, of the Moko Hinou Lighthouse, a small collection of Crustacea which had been taken between tide-marks on Moko Hinou, a group of islands off the east coast of Auckland, situated about 50 miles from Cuvier Island, where the type-specimen was obtained. Among these Crustacea there are fortunately a few specimens of *Hyale grenfelli*. Most of these are males, showing the peculiar characters in the maxillipeds and the second gnathopod as described. One

Fig. 1.

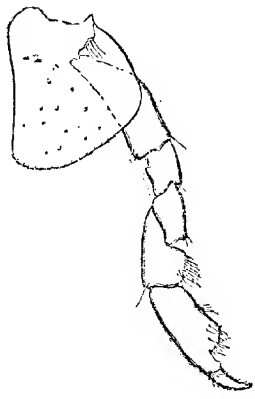


Hyale grenfelli, ♀. Maxillipeds.

specimen is a female, 5 mm. long, bearing five large eggs in the brood-pouch, and I am therefore now able to describe the characters of the female. In it the maxillipeds (fig. 1), though, perhaps, a little larger than in the majority of the species of *Hyale*, have the terminal joints only slightly enlarged, and not showing the special form nor the numerous long setæ characteristic of the male; the carpus bears one long seta at its outer distal angle and a few on the inner margin near the distal angle, but there are none on the surface of the joint itself; in the propod the inner margin

bears a regular row of long setæ and there are two rows on the surface near the outer distal end, lying more or less parallel to the distal border, and proximal to these there is one short row of four or five setæ and a single seta situated still more proximally ; the dactyl is small, very much narrower than the propod, and bears at the end a long, stout, curved seta which is proportionately much more prominent than the corresponding seta on the dactyl of the male. It will be seen that the maxilliped in the female presents the ordinary characters common to allied species of *Hyale*, and that its terminal joints show none of the numerous transverse

Fig. 2.



Hyale grenfelli, ♀. First gnathopod.

rows of long fine setæ on the surface that are so characteristic of the male.

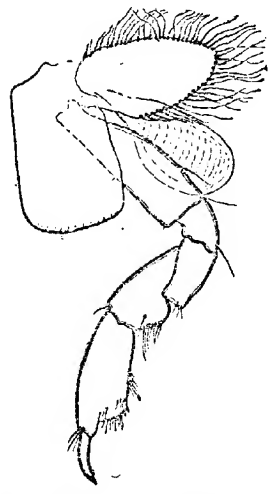
In the gnathopoda the first pair (fig. 2) are, on the whole, similar to those of the male, but more slender ; the side-plate is large, produced a little anteriorly, so that it is widest below ; the carpus bears a fringe of setæ on its posterior margin, as in the male, the propod is much more slender than the corresponding joint in the male, only widening very slightly distally, and its posterior border bears only a small tuft or short row of setæ near the centre instead of having nearly the whole of the margin fringed with a row of setæ as

in the male. The second gnathopod (fig. 3) is almost exactly the same as the first, but is very slightly larger, and the side-plate differs in being regularly rectangular and not widening below ; the other joints of the appendage show no differences from the first worthy of notice.

In other characters the female closely resembles the male.

Nearly all the males are apparently fairly well developed, and show the characters of the second gnathopod and the maxillipeds nearly as originally described. In one which is

Fig. 3.



Hyale grenfelli, ♀. Second gnathopod.

about 5 mm. in length the terminal joints of the maxilliped are rather less expanded and not quite so setose, and in the second gnathopod the propod is not so wide, the palm is more oblique and much less concave, being nearly straight or only slightly concave, and its outer and inner borders are less widely separated ; the dactyl, however, is short and fairly stout, almost as in the typical male. Doubtless in still younger specimens of the male these appendages would show the characters of the male to a still less extent and be more like those of the female.

XXII.—*Descriptions of new Lizards of the Family* Lacertidæ. By G. A. Boulenger, F.R.S.

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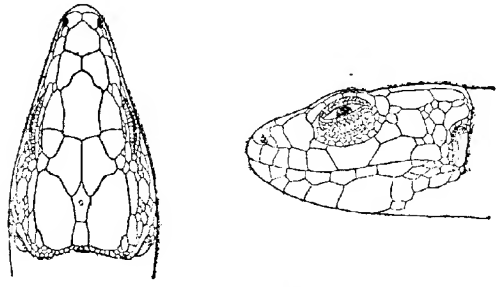
Lacerta viridis, var. *woosnami*.

Head comparatively short, its width $1\frac{2}{9}$ to $1\frac{1}{2}$ times in its length. Occipital $\frac{1}{3}$ to $\frac{2}{4}$ the length of the interparietal, not or but slightly broader than the latter; 2 to 8 granules between the supraoculars and the superciliaries; temple with 12 to 20 shields, with a large or very large masseteric, which may extend from the upper temporal to the upper labials,

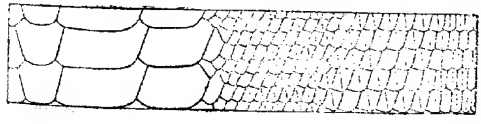
Fig. 1.



Upper and side views of head.

the tympanic well developed and usually in contact with the upper temporal. Dorsal scales rhombic and strongly keeled, considerably larger than the laterals; 38 to 43 scales across the middle of the body. Ventral plates in 6 longitudinal and 24 to 28 transverse series. 17 to 20 femoral pores on each

Fig. 2.



Lepidosis of middle of body.

side. 25 to 27 lamellar scales under the fourth toe. Green or olive-grey above, uniform or with small black spots sparsely scattered on the back, more crowded on the sides, sometimes (in a single female) forming a regular vertebral series; upper surface of head uniform green, olive, or brown; lower parts yellow, greenish, but not blue, on the throat and on the sides of the belly. Young brown or olive, with three white longitudinal streaks on the back, traces of which may be preserved in the adult; black spots may be present between them; a white streak on each side of the neck from the tympanum, continued on each side of the body or breaking up into two series of round spots; another white line along each side of the belly.

From snout to vent, ♂ 102 mm., ♀ 95; tail, ♂ 190, ♀ 207.

This form connects the var. *strigata* with the typical *L. viridis*, and especially the oriental specimens on which the name var. *caillanti*, Bedr., has been bestowed, agreeing with the latter in the temporal scutellation and the reduction in the number of superciliary granules, with the former in the presence of a light vertebral streak in the young; it differs from both in the lepidosis of the body, in respect to which it approaches *L. princeps*.

This variety is described from eight specimens obtained by the late Mr. R. B. Woosnam on the South Coast of the Caspian Sea, and from one young obtained by Mr. R. T. Günther at Bash Nurashin, N.W. Persia, which I had referred to the var. *strigata* (Journ. Linn. Soc. xxvii. 1899, p. 378).

Ichnotropis tanganicana.

Form and lepidosis as in *I. capensis*, Smith, but upper head-shields rather feebly striated and the four superciliaries in contact with the four supraoculars, only 3 or 4 small granules intervening between the second and third superciliaries and the supraoculars, and lower nasal but narrowly in contact with the rostral. 36 scales and plates round the middle of the body; ventral plates in 8 longitudinal and 25 transverse series. 11 or 12 femoral pores on each side. 19 lamellar scales under the fourth toe. Bronze-olive above, with a few small transverse blackish spots in three longitudinal series on the nape and two on the body; a black streak from the nostril to the eye, and another on the edge of the mouth; a white, black-edged streak from

below the eye, through the ear, to above the axil; white, black-edged ocellar spots on the posterior part of the back, on the hind limbs, and on the tail; lower parts white.

From snout to vent 38 mm.

This species, which I regard as the most primitive of the genus, as it is also the northernmost in its habitat, is based on a single male specimen, probably half-grown, from the East Coast of Lake Tanganyika, presented to the British Museum by Mr. W. H. Nutt in 1896.

Eremias adramitana.

Head and body strongly depressed, limbs very slender; head $1\frac{1}{2}$ times as long as broad; snout pointed, with the nasal shields rather strongly swollen, as long as broad, as long as the postocular part of the head; hind limb reaching between the collar and the ear in males, the shoulder or the collar in females; foot $1\frac{1}{3}$ to $1\frac{1}{2}$ times as long as the head; toes slender, feebly compressed; tail $1\frac{3}{5}$ to $2\frac{1}{2}$ times as long as head and body. Lower eyelid with a semi-transparent disk divided into 5 to 8 scales. Lepidosis as in *E. guttulata*, but occipital minute or absent, the parietals meeting in the middle, and ventral plates in 10 regular longitudinal series, mostly as long as broad or a little broader than long, the outer longer than broad. 31 to 40 scales across the middle of the body. 11 to 15 femoral pores on each side. Subdigital lamellæ tricarinate, 20 to 23 under the fourth toe. Fawn-coloured or pale grey above, with or without small brown spots, which may be irregular or disposed in two longitudinal series on the back, with or without small whitish spots; a dark brown lateral band, often bearing white spots, from behind the eye to the tail, bordered below by a white or yellowish lateral streak passing through the tympanum; upper surface of limbs marbled with brown, or with white spots; lower parts white.

From snout to vent 44 mm.

This species has been confounded with *E. brevirostris*, Blanf., of which the Syrian *E. bernoulli*, Schenkel, is a synonym, by Anderson, 'Herpetology of Arabia,' p. 43 (1896). It differs in the more depressed head, longer in proportion to its width, the more slender limbs, and the ventral plates constantly in ten longitudinal series. It is only known from the Hadramut, South Arabia, whilst *E. brevirostris* is on record from Kalabagh in the Punjab, Bushire in Persia, Tumb Island in the Persian Gulf, and Syria.

XXIII.—*A new Bat of the Genus* Scotæcus.

By Oldfield Thomas.

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Among a series of well-prepared skins from Nyasaland presented to the National Museum by Mr. Rodney C. Wood, there occur examples of several rare bats, notably *Myotis welwitschii* and *bocagei*, *Glauconycteris papilio*, *Eptesicus megalurus*, and a *Scotæcus* which appears to be new. The last may be called

Scotæcus woodi, sp. n.

Near *S. albofuscus* of the Gambia, but smaller.

Size about the smallest of the genus. General colour above dark brown (near mummy-brown), the tips of the hairs paler brown; under surface little paler, near Prout's brown. Wings coloured as in *S. albofuscus*, the forearms, digits, hind limbs, and tail blackish, the membranes internal to a line from elbow to knee, and the interfemoral dark brown, those external to forearms dull whitish, rather darker terminally. Ears short, with large external basal lobe; tragus short and broad, its inner margin slightly concave.

Skull short and stumpy, of the characteristic broad shape usual in the genus, the lacrymal breadth even greater than in *S. albofuscus*. Nasal notch very deep. Median part of zygoma absent in type.

Incisors slender, their bases not touching the canines. Canines broadened transversely, their basal area broader than long, and flattened behind, close and parallel to the front edge of the large premolar; no small premolar or place for it present.

Dimensions of the type (the italicized measurements taken in the flesh):—

Forearm 28·5 mm.

Head and body 56 mm.; *tail 27*; *ear 12*.

Third finger, metacarpus 28, first phalanx 10, second phalanx 8; lower leg and hind foot (c. u.) 17·5.

Skull: greatest length 13·2; median upper length 11; basi-sinual length 9·8; greatest breadth 10·3; lacrymal breadth 6·7; mastoid breadth 9·1; palato-sinual length 4·5; front of canine to back of m^3 4·9.

Hab. Southern Nyasaland. Type from Chiromo; alt. 200′.

Type. Adult male. B.M. no. 17. 2. 1. 1. Original number 173. Collected 2nd October, 1916, and presented by Rodney C. Wood, Esq.

This species may be distinguished from its only close, though geographically very distant, ally *S. albofuscus* by its smaller size, proportionally even broader skull, and the different shape of the base of its canines. The other members of the genus all have uniformly brown wing-membranes.

I may note that of twelve skulls of *Scotæcus*, including examples of all the described species, only two have complete zygomata, although all have been prepared by that most skilful skull-cleaner Mr. W. Sherrin. Imperfection or, at least, excessive tenuity of the zygoma would therefore appear to be an additional character of the genus *Scotæcus*. Of forty skulls of *Scoteinus* similarly prepared by Mr. Sherrin, nearly all have perfect, although very slender, zygomata.

XXIV.—*A new Species of* Aconæmys *from Southern Chili.*

By Oldfield Thomas.

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The British Museum has recently received from Mr. J. A. Wolffsohn a specimen of the rare genus *Aconæmys* (*Schizodon*, Waterh.) which had been presented to him by the well-known naturalist Don Carlos E. Porter. The species proving to be new, I propose to name it in honour of the latter, to whom the Museum has been indebted for help in various ways.

Aconæmys porteri, sp. n.

Fur more woolly than in *A. fuscus*; tail more completely bicolor; incisors stouter.

Size about as in *A. fuscus* or rather smaller. Fur soft, more woolly, less straight than in *A. fuscus*, the general texture and the colour both suggesting that of a European water-vole (*Arvicola amphibius*). General colour deep rich brown, near "auburn" of Ridgway, the subterminal rings on the hairs dull cinnamon. Under surface similar but rather warmer in tone, the ends of the hairs rich cinnamon. Hands and feet greyish white, the middle part of the metatarsus rather darker. Tail rather longer than in *A. fuscus* and completely bicolor, black above and creamy whitish below for

its whole length; in *A. fuscus* the terminal part of the under surface is brown.

Skull apparently somewhat smaller than in *A. fuscus*, but the age of the type is not very certainly determinable. Anterior part narrower, the breadth between the outer corners of the anteorbital foramina and the interorbital breadth both distinctly less.

Incisors very stout and heavy, decidedly thicker than in specimens of *A. fuscus* of apparently similar age.

Dimensions of the type:—

Tail (vertebræ in skin) 64; hind foot (dry) 28.

Skull: tip of nasals to back of frontals 28·5; greatest breadth 23; nasals 15 × 6·3; interorbital breadth 7·5; breadth between outer corners of anteorbital foramina 17·6; palatilar length 16·2; front of incisors to back of m^3 21·5; upper tooth-row (crowns) 8·4; combined breadth of upper incisors 4·7.

Hab. Osorno, S. Chili.

Type. Adult. B.M. no. 16. 11. 14. 4. Presented by Don Carlos E. Porter to Mr. J. A. Wolffsohn.

The British Museum contains eleven specimens of *Aconæmys fuscus*, received at different dates from Mr. T. Bridges, but whether all were from the "Valle de Las Cuevas, on the east side of the Andes, near the Volcano of Peteroa, altitude 6000′," where Mr. Bridges discovered the species, there is, unfortunately, no evidence to show. But all agree in the characters used above in separating the southern form, which is probably an inhabitant of the high slopes on the Volcano of Osorno, some little distance from the town of the same name.

Since the time of Mr. Bridges no examples of this genus have come to the British Museum, nor has our indefatigable correspondent Mr. Wolffsohn been able to see or hear of any. Consequently this additional specimen, representing a second and more southern species of the genus, is an extremely welcome accession.

XXV.—*Descriptions and Records of Bees.*—LXXIV.

By T. D. A. Cockerell, University of Colorado.

All the bees recorded in the present part are in the U.S. National Museum.

Andrena lugubrescens, n. n.

Andrena lugubris, Lepeletier, 1841 (not Erichson, 1840).

♂.—Belvidere, Tunis, May 10, 1899 (*P. Magretti*).

This is like the male of *A. albopunctata*, Rossi, but has the abdomen shining, irregularly wrinkled, and with scattered minute piliferous punctures, so it is doubtless the male of *A. lugubris*, described by Lepeletier from the female only.

Length about 12 mm.

Process of labrum prominent, shining, truncate, slightly emarginate; first recurrent nervure joining second submarginal cell distinctly before the middle.

The name *lugubris* is preoccupied, so *lugubrescens* is proposed as a substitute.

Andrena cussariensis, Morawitz.

♀.—Kohat, N.W. Provinces, India, March 1906 (*Frank Benton*).

Superficially this looks like *A. morio*, which Bingham records from the Simla hills; but it is certainly distinct from *morio*, and, as far as can be gathered from Morawitz's quite full description, agrees well with *cussariensis*. The abdomen has very fine punctures, and the process of labrum is much narrower than in *morio*. The species is more closely allied to *A. ephippium*.

Andrena cussariensis kohatensis, var. nov.

♀.—Length about 14·5 mm.

Scutellum and broad bands at sides of mesothorax terra-cotta red.

Hab. Kohat, India, March 1906 (*Frank Benton*).

This variety suggests comparison with *A. ephippium*, Spin., to which it is closely allied. It differs from *ephippium* by the narrower thorax, the scutellum much narrower, and less closely punctured on disc; the flagellum only very obscurely reddish beneath, the shorter fourth antennal joint, the less strongly sculptured area of metathorax, and the broad hind margin of first abdominal segment excessively finely punctured, abruptly contrasting with the rest of the segment. The hair of hind legs is entirely black.

Should comparison of specimens indicate that this species is to be separated from *A. cussariensis*, it may be known as *A. kohatensis*.

Andrena chionospila, sp. n.

♀.—Superficially exactly like *A. albopunctata*, Rossi (specimen from Ras-el-Ma, Algeria, compared), but differing thus:—Antennæ shorter; process of labrum, although very

broad, not so broad; area of metathorax smaller, less rugose; punctures of abdomen conspicuously more feeble and less dense; white hair-patches at sides of abdomen larger.

♂.—Very like the female, except in the usual sexual characters; head very broad; region of mouth, sides of face, and region of antennæ with long black hair, but face otherwise with long white hair, which is dull, not clear white as in ♀; cheeks broad, with black hair; abdomen less distinctly punctured.

Hab. Menserah, N.W. Provinces, India, March 1906 (*Frank Benton*).

Perhaps a subspecies of *A. albopunctata*.

Andrena subspinigera, sp. n.

♀.—Length about 11 mm.

Head, thorax, and legs black; abdomen with the first three segments clear ferruginous (the first with a broad transverse black band, the third with an interrupted suffused dark band beyond the middle), the others black, the third and fourth with heavy fringes of pure white hair, the second with a thin inconspicuous fringe, the caudal fimbria brownish black. Hair of head and thorax white, with a slight creamy tint on thorax above; facial foveæ rather narrow, seen from above shining white, with the upper end brown; facial quadrangle broader than long; process of labrum broad and obtuse, with sloping sides; clypeus dull except at sides, with sparse punctures; flagellum bright ferruginous beneath except at base; third antennal joint almost as long as next three together; mesothorax and scutellum dull, without well-defined punctures, the long hair not concealing the surface; area of metathorax dull, minutely granular, scarcely defined; tegulæ pale yellowish testaceous. Wings strongly reddened, stigma and nervures rufo-fuscous; b. n. meeting t.-m.; second s.m. large, receiving first r. n. considerably beyond middle. Scopa of hind tibiæ compact, fuscous behind (above), white in front; basitarsi broad and flat. Abdomen dull, minutely granular, without any evident punctures.

Hab. Menserah, N.W. Provinces, India, March 1906 (*Frank Benton*). On some labels the locality is written "Manserah," on others "Menserah."

This species is very like *A. spinigera*, Kirby, from Quetta, but differs by the flagellum red beneath, the dusky reddish wings, the dull abdomen, &c.

Andrena quettensis, sp. n.

♂.—Length about 9 mm.

Black, the hind tarsi, apical half of middle tarsi, broad apical band on first abdominal segment, and second segment except a spot on each side and a dusky cloud in middle (or only the apical margin and a broad semilunar area on each side basally) all ferruginous red. Head broad, facial quadrangle much broader than long; mandibles rather short, red at end; process of labrum broadly emarginate; no light face-marks; clypeus dull and granular; face and front covered with long sooty hair, paler and reddish about middle of face, becoming black around margins; occiput and lower part of cheeks with long pale fulvous hair; cheeks broad, but rounded behind; antennæ long, reaching metathorax; flagellum thick, crenulate, entirely dark; mesothorax and scutellum dull; area of metathorax triangular, coarsely wrinkled, poorly defined; hair of thorax long and fulvous; tegulæ fuscous, the outer margin paler. Wings long, reddish hyaline, stigma and nervures amber-colour; second s.m. receiving first r.n. well beyond middle. Legs with pale hair, golden on inner side of tarsi. Abdomen shining, the dark segments beyond the middle with a very slight, hardly observable, greenish tint; segments with very thin bands of long pale hair; apical plate broadly emarginate.

Hab. Quetta, India, March 1906 (*Frank Benton*).

This does not agree with any of the species reported by Nurse from Quetta; the nearest is *A. balucha*, Nurse, which has more red on the abdomen and much paler hair on head. It is just possible that *A. quettensis* represents an extreme colour-variation of *A. balucha*, but it seems to be quite distinct. In Apidæ Europeæ *A. quettensis* runs to *A. cingulata* and *A. laticeps*, but differs at once by the colour of hair on head. *A. balucha*, which I have examined in U.S. National Museum, has the area of metathorax of the *Trachandrena* type.

Andrena bentoni, sp. n.

♀.—Length about 9 mm.

Black, including legs and abdomen; hair of head and thorax abundant, erect, but not hiding surface, very pale greyish ochreous, black on vertex; facial quadrangle considerably broader than long; clypeus shining, strongly and closely punctured, without any distinct smooth line; mandibles red apically; process of labrum broadly truncate;

facial foveæ reddish brown, separated from eye by a distinct punctured band; flagellum obscure brownish beneath except at base; third antennal joint about as long as next three together; fourth and fifth short and about equal, sixth longer; mesothorax dull, closely and distinctly punctured; scutellum shining; area of metathorax granular, minutely plicate at extreme base; tegulæ fuscous, posteriorly ferruginous. Wings strongly reddened, stigma and nervures ferruginous; second s.m. receiving first r. n. in middle. Legs with pale hair, scopa of hind tibiæ dense, entirely pale golden fulvous. Abdomen broad and flattish, glistening, very finely and closely punctured, second segment depressed hardly one-fourth; hind margins of segments 2 to 5 with rather weakly developed white hair-bands; apical fimbria dark chocolate.

Hab. Menserah, N.W. Provinces, India, March 1906 (*Frank Benton*).

In Apidæ Europeæ *A. bentoni* appears to fall nearest to *A. propinqua* and *A. separanda*, but the hair of thorax is quite differently coloured. There is no close resemblance to any of the Indian species.

Andrena præcocella, sp. n.

♂.—Length 7·5–8·5 mm.

Black, with long black and white hair. Very close to *A. præcox*, Scop., but differing thus:—Hind margins of second and third abdominal segments more or less brown or red; mandibles with no basal tooth beneath; head equally broad, but longer; upper part of cheeks punctured; light hair of thorax above white (not yellowish); fourth and fifth abdominal segments with thin white hair-bands; apical plate of abdomen emarginate, shaped like a fish-tail.

Compared with the Japanese *A. præcociformis*, Ckll., it differs by the large amount of black hair at sides of face, the cheeks strongly angled behind, the black hair on metathorax, &c.

Hab. Quetta, India, March 1906, 5 ♂ (*Frank Benton*).

The females of this group are very unlike the males, so I thought it possible that Nurse might have described the species from Quetta in the female sex. There is, however, no description which seems possibly applicable. In *A. præcocella* the fourth antennal joint is about 256 microns long, the fifth 320. The mandibles are long and falciform.

Apis florea nasicana, Cockerell.

Kohat, N.W. Provinces, India, March 1906 (*Frank Benton*).

Tetralonia pomona (Nurse).

Both sexes; Quetta, India, March 1906 (*Frank Benton*).

Tetralonia kohatensis, sp. n.

♂.—Length 8·5–10 mm.; antennæ about 6·5 mm.

Black, with the small joints of tarsi ferruginous; clypeus, labrum, and basal half of mandibles clear sulphur-yellow; mandibles red in middle and black apically; antennæ long and slender, bright ferruginous beyond the third joint, the upper side dusky; third antennal joint much longer than its apical width, dark fuscous, abruptly contrasting with fourth; eyes green; maxillary palpi rather short, but six-jointed; head and thorax above, as well as front and upper part of face, with long pale fulvous hair, cheeks and underside of thorax with white hair; disc of mesothorax shining; tegulæ light reddish fulvous. Wings clear, faintly brownish in apical field; stigma and nervures reddish fuscous; first r. n. meeting second t.-c. or falling a little short of it; marginal cell obliquely truncate. Outer side of tibiæ with dense white hair; tarsi with ferruginous hair on inner side; spurs creamy white. Abdomen shining, with piliferous punctures; apical margin of segments broadly pallid, covered with dense bands of pale ochreous tomentum, of equal width right across, the band on first segment narrow; no definable basal bands; lateral margins of sixth segment briefly dentate.

Hab. Kohat, N.W.Provinces, India, 4 ♂, March 1906 (*Frank Benton*).

Related to *T. erythrocera*, Cam., but easily separated by the fulvous hair. Superficially the insect is exactly like *Tetraloniella aliena*, Ckll.

Anthophora conexiformis, sp. n.

♂.—Length about 14 mm.

Robust; black, including legs and antennæ (except a very small cream-coloured line on scape), with a short linear creamy mark on each orbital margin below level of antennæ, and a large cream-coloured area on clypeus, broad below, narrowed to a band above (inverse goblet-shaped), but labrum and mandibles wholly black; eyes bright ochreous; facial quadrangle much longer than broad; mandibles with a large rounded tooth on inner side; malar space well developed; third antennal joint fully as long as next three united, the fourth very short; clypeus, labrum, cheeks (except upper part anteriorly), and occiput densely covered

with very long pure white hair; front, vertex, sides of face, and upper part of cheeks anteriorly with black hair; thorax with very long hair, mixed grey and white, dark on scutellum, shining white on mesopleura; tegulæ black, very hairy. Wings hyaline. Legs slender, with long black and white hair, dark chocolate on inner side of tarsi; apical joint of middle tarsi with no noticeable fringe; hind basitarsus long and broadened. Abdomen not banded or spotted, but with a profusion of long erect hair, which is mostly greyish white, but black on discs of fourth and following segments, though white and very long at sides.

Hab. Quetta, India, March 1906 (*Frank Benton*).

Closely allied to *A. connexa* (Nurse), also from Quetta; but according to Nurse's description *connexa* has the clypeus all yellow, the apical tarsal joints more or less rufo-testaceous, the blackish hair of abdomen confined to the apical two segments, and the front with white hair. It thus seems probable that our insect is a distinct species, though it may be only a variety. There is a pencil of white hair on each side of front, a little above level of antennæ. The general appearance of the insect is very like that of *Tetralonia pomona*.

Anthophora (*Micranthophora*) *albopicta*, sp. n.

♀.—Length about 11 mm., anterior wing 8 mm.

Black, including the legs and antennæ, but mandibles ferruginous with the lower basal corner broadly black; labrum black, with a very broad white band down the middle; clypeus with a large apical white triangle, attenuated above, this on a light ferruginous field, which extends as a band to upper margin, but the upper half of clypeus black except in middle; eyes greyish ochreous, converging below, the front very broad; flagellum very obscurely reddish beneath; third antennal joint about 640 microns long, the next three together about 735; maxillary palpi with stout bristles, except on the last two joints; third joint of labial palpi 560 microns from base to origin of fourth joint; pubescence very pale ochreous, nearly white, long on head and thorax; on head and thorax above with black hairs intermixed; mesothorax extremely densely punctured; tegulæ piceous. Wings hyaline, with a very faint brownish tint. Legs with creamy white hair, rusty black on inner side of hind tibiæ and tarsi, anterior and middle tibiæ with a small patch of ferruginous hair at apex. Abdomen broad,

hind margins of segments whitish hyaline; whole surface of dorsal segments rather thinly covered with appressed pale hair, not forming bands; apex with a patch of black hair; apical plate very long and narrow.

Hab. Kotal Malul, S. Persia, Feb. 1906 (*Frank Benton*).

A typical *Micranthophora*, looking just like the Californian *A. anstrutheri*, Ckll., though differing in the face-markings and many other details. It is also related to the Indian *A. candida*, Sm., but the pubescence of the abdomen in that species is much more dense, the face-markings are different, and the flagellum is red beneath.

Anthophora cincta (Fabricius).

Axim, Gold Coast, Africa (*C. R. Mengel*).

Anthophora antimena, Saussure.

Mahanoro, Madagascar, May 5, 1895 (*W. L. Abbott*).

Anthophora acraensis (Fabricius).

Luebo, Congo (*D. W. Snyder*).

Anthophora flavicollis, Gerstaecker.

Axim, Gold Coast, Africa (*C. R. Mengel*).

Anthophora leucorhina, sp. n.

♂ (type).—Length about 15 mm.

Black, including flagellum and legs, except the reddish apical joint of tarsi; face-marks creamy white, including clypeus, labrum (except large black spot at each basal corner, and black apical margin), elongate spot on base of mandibles, narrow stripe along each anterior orbit (beginning at about level of antennæ, but not reaching lower corner of face), and anterior surface of scape; clypeus prominent, convex; third antennal joint about as long as next three combined; face and cheeks with long pure white hair, occiput with yellowish, vertex and front with black hair, but some white on each side of antennæ, and some long black hairs at sides of face; malar space well developed; thorax with abundant long hair, pale greyish-yellow above and on upper part of sides,

black on anterior part of scutellum, and white on lower part of pleura; mesothorax dull, slightly shining on disc; tegulæ piceous. Wings hyaline, very faintly brownish apically. Legs with long white hair; middle tarsi not modified, nor with any black fringe on last joint; hind basitarsi not toothed. Abdomen shining, with piliferous punctures, the surface covered with long hair, pale greyish-yellow on first two segments, black on the others, but hind margins of segments 2 to 4 with loose bands of white hair; venter with long white hair.

♀.—Length about 16 mm.

Tongue very long; no pale face-marks, but a red tubercle on each side of base of labrum, and malar space red; hair of front pale; disc of mesothorax and anterior part of scutellum with some dark hair, not conspicuous; tegulæ rufo-testaceous; patches of fulvous hair at apices of anterior and middle tibiæ and on hind knees; hair on inner side of hind tibiæ (except base) black, on inner side of hind tarsi largely red, in some lights appearing rich fox-red with black margin; abdomen with broad pale hair-bands on segments 2 to 4; apex with black hair; apical plate long and narrow; venter with white fringe on segments 2 to 4, but dense black hair on apex of 5.

Hab. Kotal Malul, S. Persia, Feb. 1906 (*Frank Benton*), 2 ♂, 1 ♀.

Resembles *A. cinerea* (Friese), from Sarepta, but is considerably larger. There is a general resemblance to *A. crinipes*, Sm., but the middle tarsi are not modified as in that species, and *crinipes* has a linear malar space. By the white face-marks and prominent clypeus the male resembles *A. dives*, Dours, of which I have a specimen marked "cotype" from Gribodo, but the legs are entirely different. Friese makes *dives* a synonym of *A. dufourii*, Lep., but it is possibly separable, the male (at least) having no metallic colour on abdomen, the middle tarsal joints of middle leg longer and slenderer than in Friese's figure, and the brush on last joint wider. They agree, however, in the remarkable hind basitarsi.

Osmia (*Ceratosmia*) *balucha*, Nurse.

Quetta, India, March 1906 (*Benton*).

The male has the middle femora strongly produced and angulate beneath, but the hind basitarsi are not dentate.

BIBLIOGRAPHICAL NOTICE.

Catalogue of the Lepidoptera Phalænæ. Supplement, Vol. I. London: the Trustees of the British Museum. 1914–15.

Since the publication of the first two volumes of the 'Catalogue of Moths' a formidable number of species in the families therein included have since been described. Hence it became necessary to prepare a supplement in order that the subject-matter of these volumes might be brought up to date. The present volume, with a smaller containing the plates, represents the first instalment of that supplement.

Some idea of the number of species which have been added to the lists may be gathered from Dr. Gahan's Preface to Sir George Hampson's work. Thus, the family Amatidæ in vol. i. contained 169 genera and 1184 species, to which are now added 16 genera and 945 species. The family Nolinæ in vol. ii. had 13 genera and 162 species, to which are added 1 genus and 116 species; while the Lithosianæ in vol. ii. had 244 genera and 1055 species, to which are added in this Supplement 73 genera and 880 species! A supplementary volume to vol. iii. is in progress.

Whether all the species recognized in this Catalogue are really "good species" is evidently a matter for debate, since the author, in this Supplement, frequently admits of this or that new species that it is "very possibly" the male or female, or even a "variety," of some other specific form.

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.

December 6th, 1916.—Dr. Alfred Harker, F.R.S., President, in the Chair.

Mr. G. C. Crick, A.R.S.M., F.G.S., gave an account of some recent researches on the belemnite animal. He stated that it was not his intention to deal that evening with the homologies of the belemnite shell or with the phylogeny of the belemnite group, but to confine himself to the restoration of a typical belemnite animal and its shell, as shown particularly by examples in the British-Museum collection.

He first demonstrated, by means of a rough model, the construction of the belemnite shell, including the guard or rostrum, the phragmocone with its ventrally-situated siphuncle, and its thin envelope the conotheca, with its forward prolongation and expansion (on the dorsal side) known as the pro-ostracum. He then

exhibited photographic slides of examples in the British-Museum collection showing these various characters, and noted the abrupt termination of the chambered cone on the lower part of the pro-ostracum, of which the dorsal surface may have been partly or almost completely covered by a thin forward extension of the guard. To illustrate what was known of the complete body of the animal as found associated with the guard, he then showed photographic slides of two of the examples figured by Huxley in his 'Memoir on the Structure of the Belemnitidæ' published in 1864. Each of these exhibited the guard associated with portions of the pro-ostracum, the ink-bag, and the hooklets of the arms. The form of the hooklets with their thickened bases was discussed, this feature in a great measure justifying the attribution to the belemnite of certain cephalopod remains (found practically at about the same geological horizon) that included uncinated arms associated with an ink-bag, and frequently also with nacreous portions of (presumably) the pro-ostracum.

Of the remains of uncinated armed cephalopods from the Lias, each exhibiting the same form of hooklets as those figured by Huxley, he said that the British-Museum collection contained seventeen examples, all from the neighbourhood of Lyme Regis and of Charmouth, in Dorset. Each specimen exhibits a number of uncinated arms associated usually with an ink-bag, sometimes also with nacreous matter, and in two instances also with the guard or rostrum. These two examples were those to which he had already referred as having been figured by Huxley, and unfortunately the arms are not well preserved in either of these specimens; in one (*B. bruguierianus*, from the Lower Lias near Charmouth) there are only a few scattered hooklets, while the arms of the other (*B. elongatus*, from the Lower Lias of Charmouth) are represented only by a confused mass of hooklets. Of the other fifteen examples, in one there are a few solitary hooklets; in another the number of the arms is very indistinct; in two the remains of only two arms are preserved; in one there are traces of three arms; in two there are indications of three, or possibly four, arms; and in one there is a confused mass of possibly four arms; and in one there are the remains of four, or possibly of five, arms. In each of the remaining six specimens six arms can be more or less clearly made out, while there is not a single example in which more than six uncinated arms are displayed.

Of the six examples that exhibit six uncinated arms four are stated to be from the Lias of Lyme Regis; one is from the Lias of Charmouth; and one was obtained from the Lower Liassic shales between Charmouth and Lyme Regis. From a consideration of these specimens, the speaker concluded that the cephalopod represented by these uncinated arms is the animal known as the belemnite, and that the six uncinated arms were arranged in three pairs of unequal length, of which the longest pair was lateral, the medium-sized pair probably dorsal, and the shortest pair probably

ventral. He considered the presence of tentacular arms to be doubtful. These observations were in accord with those of Huxley, who, in his 'Memoir' already cited, stated that he had 'not been able to make out more than six or seven arms in any specimen, nor has any exhibited traces of elongated tentacula, though the shortness of the arms which have been preserved would have led one to suspect their existence.'

The speaker regarded certain markings sometimes to be seen on the guard as indicating that during the life of the animal the guard was almost, if not entirely, covered by the mantle, in which case it was highly improbable that the guard was pushed into the soft mud of the sea-bottom in order to act as an anchor.

He considered the animal to have been a free swimmer, swimming forward ordinarily, but when desirable, capable also of sudden and rapid propulsion backwards.

A short discussion followed, and the thanks of the Fellows present were accorded to Mr. Crick for his lecture.

December 20th, 1916.—Dr. Alfred Harker, F.R.S., President, in the Chair.

Marie C. Stopes, D.Sc., Ph.D., gave an account of some recent researches on Mesozoic 'Cycads' (Bennettitales), dealing particularly with recently-discovered petrified remains which reveal their cellular tissues in microscopic preparations. To make the significance of the various fossil forms clear, Dr. Stopes first showed some lantern-slides of living Cycads, and then pointed out that it was in their external features and in their vegetative anatomy only that the fossil 'Cycads' were like the living forms; the most important features, the reproductive organs, differ profoundly in the two groups, and the fossils were fundamentally distinct, not only from the living Cycads, but from all other living or fossil families.

The fossils representing the group that are most frequently found are (*a*) trunks, generally more or less imperfect casts or partial petrifactions, and sometimes excellent petrifactions preserving anatomical details and cell-tissues; (*b*) impressions of the foliage. Not infrequent are the detached impressions of incomplete 'flowers' or cones, of one cohort (the Williamsoneæ), while petrified fructifications are numerous in some of the well-petrified trunks of the Bennettiteæ. The described species of the group run into hundreds, but probably many of these duplicate real species, because the foliage, trunks, pith-casts, various portions of the fructifications, etc., have often been separately found and named. In very few cases have the different parts been correlated. The species of the foliage are the most generally known, as they are the most readily recognized with the naked eye: they have been described under a variety of generic names.

The following table gives the proved, or probable, associated parts of some members of the group:—

Foliage.	Trunk.	Fructifications.
Zamites spp.	*Bennettites* spp.	*Bennettites* spp.
Zamites gigas.	Attached, no separate name.	*Williamsonia gigas.*
Otozamites sp.	.....	*Williamsonia spectabilis.*
Ptilophyllum pectinoides.	.....	*Williamsonia whitbiensis.*
Anomozamites minor.	(Only slender branches known, no name.)	*Wielandiella angustifolia.*
Tæniopteris vittata.	.....	*Williamsoniella coronata.*

Dr. Stopes exhibited slides of microphotographs of the stem and leaf-base anatomy of the group, including some unpublished details of *Bennettites maximus*. The roots of the group have hitherto been entirely unknown, and a slide was exhibited for the first time showing rootlets penetrating the leaf-bases of a petrified specimen (represented by a section in the Geological Department of the British Museum—Natural History). These roots probably belong to *B. saxbyanus*: they are covered with wonderfully petrified root-hairs, running uncollapsed through the silica matrix. They raise interesting questions concerning the possible chemical conditions of the infiltration of the silica. Illustrations were also exhibited of the famous complex 'flower' and cone-structures, and of Wieland's brilliant restorations of the same. Microphotographic slides were exhibited of the seed-cone of an interesting unpublished new species from the British Gault. This is beautifully petrified, and adds to our knowledge of the finer anatomy of the seeds and associated structures. It is also the largest cone of the Bennettitales yet known, though it occurs in the Gault, by which time the group appears to have begun rapidly to die out.

The following table indicates the distribution of a few of the most interesting representatives of the Bennettitales (including the cohorts Bennettiteæ and Williamsoneæ):—

Upper Cretaceous.	Very fragmentary and uncertain records; apparently the group is nearly or quite extinct.	
Middle Cretaceous; Gault.	The new large-sized seed-cone. *B. morierei* ♀ (? described originally from the Jurassic).	
Lower Cretaceous; Lower Greensand.	Well-petrified trunks with fructifications. *B. gibsonianus* (type-species of the Bennettiteæ).	
	B. maximus.	Throughout these periods in America trunk-remains very abundant, often petrified and with fructifications, particularly from the Black Hills, South Dakota.
Potton Sands.	Trunks, e.g. *Colymbetes edwardsi.*	
Wealden.	Trunks (casts and petrifactions), foliage, *B. saxbyanus.*	
Jurassic; Purbeck.	Trunks (casts and semi-petrifactions). Buckland's original *Cycadeoidea* spp. (*C. gigantea*,	

Oolites.	Trunks, pith-casts, etc. Much foliage of various types. *Williamsonia gigas* and other fruit-impressions.	and Maryland. *C. jenneyana*, *C. ingens*, *C. vielandi*, etc.
	W. scotica.	
Lias.	*Williamsoniella coronata.* Foliage and *Williamsonia* fruits (India).	Rich impressions in Mexico of *Williamsonia* and many foliage genera.
Rhætic.	*Wielandiella angustifolia* and foliage.	

The group is by far the most characteristic of all the plants of the Jurassic and Lower Cretaceous, during which periods its distribution was almost world-wide. It was locally, if not universally, dominant, and was the most highly evolved plant-group of the epoch of which we are cognizant.

Three chief points of interest are to be noted in the geological distribution of these plants: (*a*) that the most numerous highly-specialized trunks reach their maximum in the Jurassic and Lower Cretaceous Periods, when their distribution was practically world-wide: (*b*) that the oldest and therefore presumably the most primitive type, *Wielandiella*, is externally less like the living cycads than the commoner later forms, while these latter are utterly unlike the living genera in their fructifications; (*c*) that the geologically youngest cone is the largest yet discovered, occurring in the Gault when the extinction of the group appears already to have set in.

Contrary to what might have been anticipated from their external likeness to the living Cycads, coupled with their great geological age, the fossil 'Cycads' are much more complex and on a higher level of evolution than the living group. It seems to the Author to be extremely unlikely that the fossil and the living forms have any direct phylogenetic connexion nearer than a remote, unknown, common ancestor. The mooted connexion between the fossil 'Cycads' and the Angiosperms is highly suggestive, but lacks data for its establishment.

A short discussion followed, and the thanks of the Fellows present were accorded to Dr. Stopes for her lecture.

January 10th, 1917.—Dr. Alfred Harker, F.R.S., President, in the Chair.

The following communication was read:—

'Balston Expedition to Peru: Report on Graptolites collected by Capt. J. A. Douglas, R.E., F.G.S.' By Charles Lapworth, LL.D., M.Sc., F.R.S., F.G.S.

The specimens of graptolites were collected from the rocks of the Inambari district in Peru by Capt. Douglas, under whose name

the collection has been placed in the Geological Department of the University Museum, Oxford. These fossils were forwarded by Prof. W. J. Sollas to Prof. C. Lapworth, who embodied the results of his study in a Report, of which the following is a brief abstract.

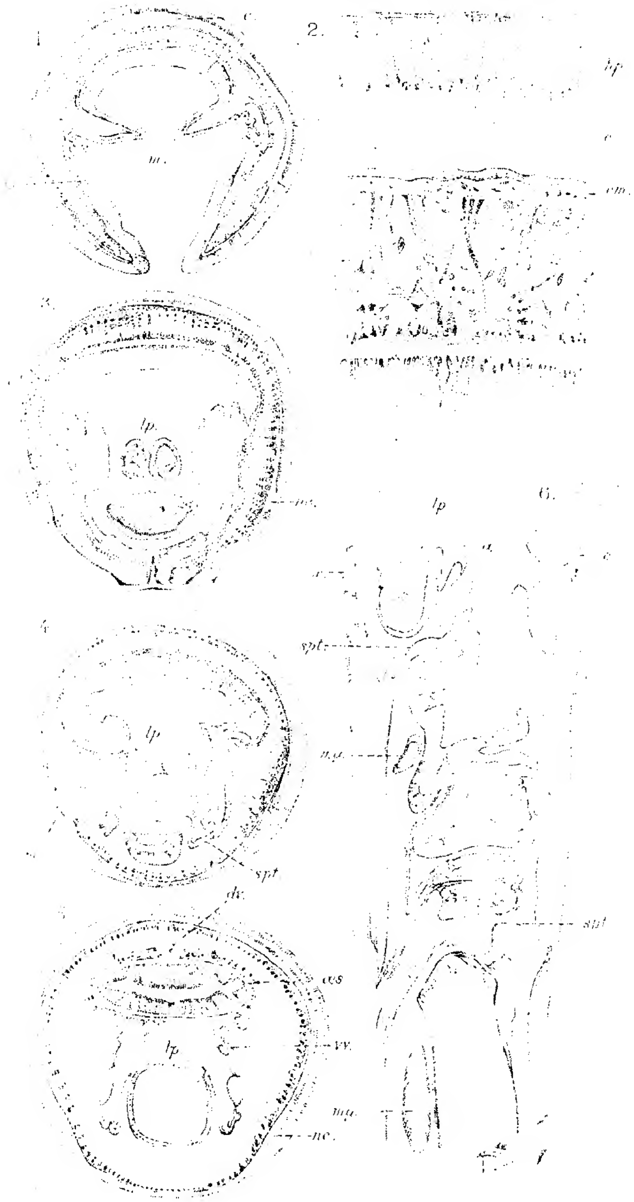
The specimens are recorded as all occurring in the same locality, but it is not known whether they were obtained from a single zone. The majority of the rock-specimens in which the graptolites occur are black and somewhat pyritous carbonaceous shales, usually well bedded and uncleaved, and the graptolites are in general well preserved. The lithology of the containing rocks and the mode of preservation of the graptolites are similar to those obtaining in the richest graptolite-bearing strata of Britain, Europe, and North America.

The forms apparently represented in the collection are *Loganograptus logani* Hall, a new species of *Goniograptus (?)*, *Didymograptus stabilis* Elles & Wood and *D. bifidus* Hall, *Phyllograptus angustifolius* Hall, *Glossograptus acanthus* Elles & Wood, *Cryptograptus tricornis* Hall, var., *Amplexograptus confertus* Lapworth, and *A. cælatus* Lapworth.

Taken as a whole, this graptolite fauna may best be compared with that of the Upper Arenig formation of Britain and its North-American equivalents, answering to the Lower Llanvirnian of Hicks & Marr and the *Didymograptus-bifidus* Zone of Elles & Wood and H.M. Geological Survey.

The assemblage of graptolites discovered in Bolivia a few years ago by Dr. J. W. Evans corresponds very closely with this Peruvian fauna, and was probably derived from the southward continuation of the same Andean graptolite-band. The Peruvian forms in the Douglas collection, like those from Bolivia, admit almost as close a parallelism with those of the Arenig-Llandeilo graptolite-beds of Australia and New Zealand as with their representatives in the Northern Hemisphere.

Not only is the Douglas Collection of Peruvian graptolites instructive and valuable from the palæontological point of view, owing to the number and the good state of preservation of the species represented, but it is of especial interest from the palæographical aspect, as affording additional proof of the identity (in general facies) of the graptolite fauna of the sea-waters of Lower Ordovician times in those regions of the globe which are now occupied by some of the dry lands of Britain, Eastern North America, Peru, Bolivia, Victoria, and New Zealand. Thus it greatly strengthens the inference that in Arenig-Llandeilo times there was open-sea communication admitting of the circulation of sea-currents along some as yet undetermined line or lines, connecting the above-mentioned regions, which must have extended across the Equator and apparently throughout a length nearly equal to that of half the circumference of the globe.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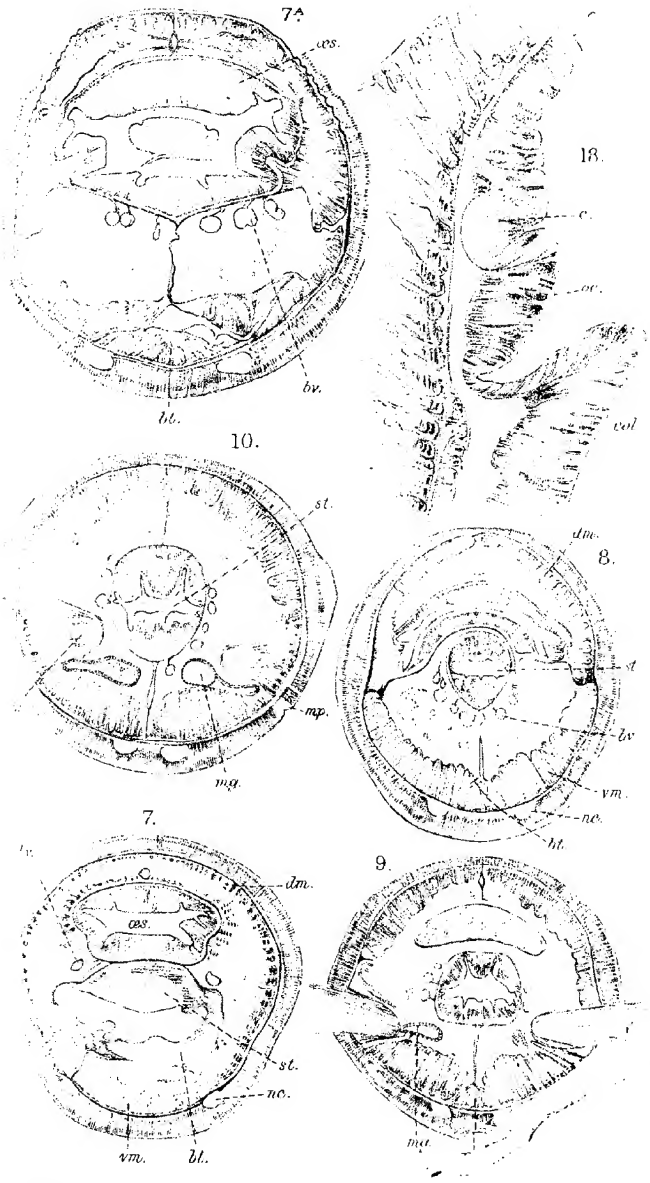
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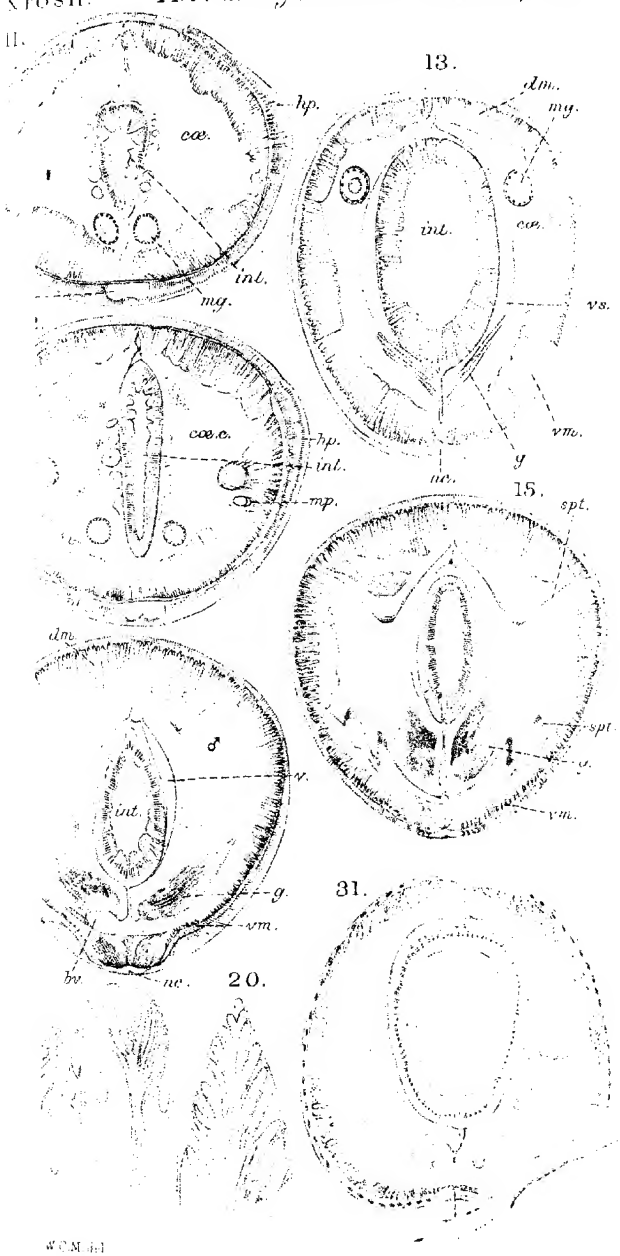
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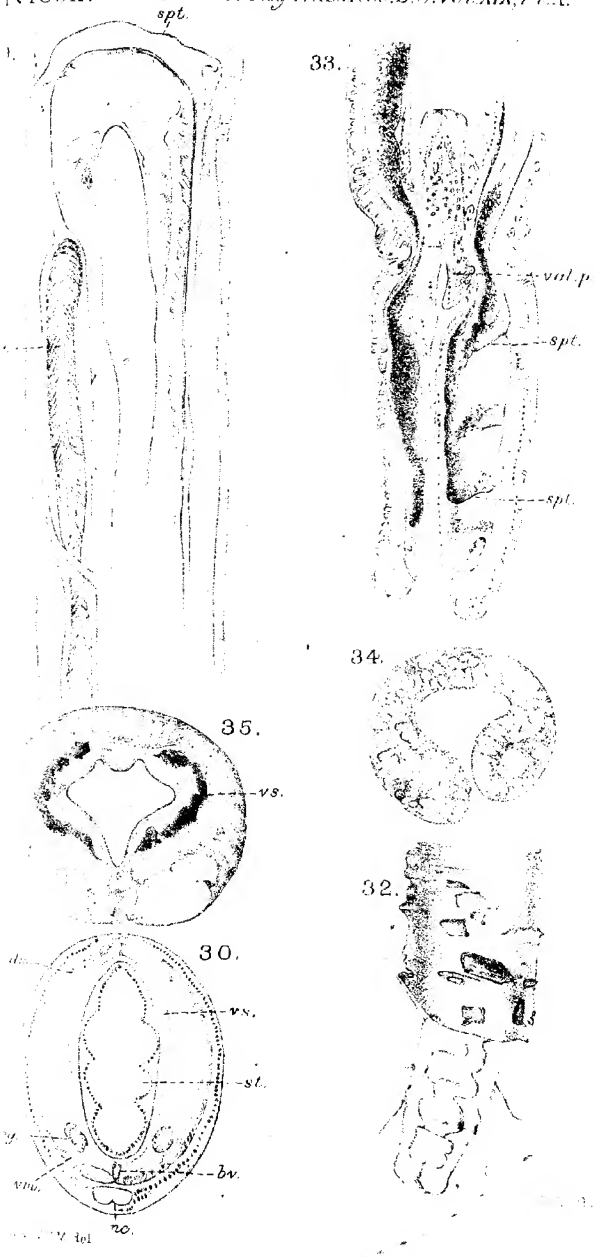
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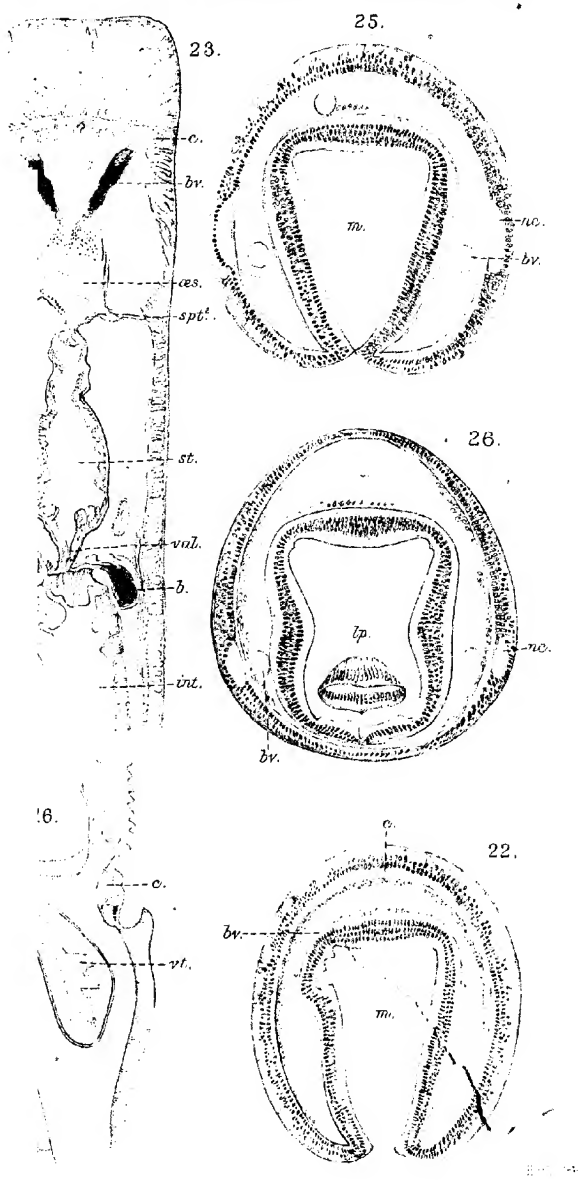

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